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Silver Pen Has the Write Stuff for Flexible Electronics

University of Illinois engineers developed a pen with conductive silver ink that can write electric circuits and interconnects directly on paper and other surfaces. (Credit: Photo by Bok Yeop Ahn)

ScienceDaily (June 29, 2011) — The pen may have bested the sword long ago, but now it's challenging wires and soldering irons. University of Illinois engineers have developed a silver-inked rollerball pen capable of writing electrical circuits and interconnects on paper, wood and other surfaces. The pen is writing whole new chapters in low-cost, flexible and disposable electronics.

Led by Jennifer Lewis, the Hans Thurnauer professor of materials science and engineering at the U. of I., and Jennifer Bernhard, a professor of electrical and computer engineering, the team published its work in the journal *Advanced Materials.*

"Pen-based printing allows one to construct electronic devices 'on-the-fly,' " said Lewis, the director of the Frederick Seitz Materials Research Laboratory at the U. of I. "This is an important step toward enabling desktop manufacturing (or personal fabrication) using very low cost, ubiquitous printing tools."

While it looks like a typical silver-colored rollerball pen, this pen's ink is a solution of real silver. After writing, the liquid in the ink dries to leave conductive silver pathways -- in essence, paper-mounted wires. The ink maintains its conductivity through multiple bends and folds of the paper, enabling devices with great flexibility and conformability.

Metallic inks have been used in approaches using inkjet printers to fabricate electronic devices, but the pen offers freedom and flexibility to apply ink directly to paper or other rough surfaces instantly, at low cost and without programming.

"The key advantage of the pen is that the costly printers and printheads typically required for inkjet or other printing approaches are replaced with an inexpensive, hand-held writing tool," said Lewis, who is also affiliated with the Beckman Institute for Advanced Science and Technology.

The ability to create freestyle conductive pathways enables new possibilities in art, disposable electronics and folded three-dimensional devices. For example, the researchers used the silver pen to sketch a copy of the painting "Sae-Han-Do" by Jung Hee Kim, which portrays a house, trees and Chinese text. The ink serves as wiring for an LED mounted on the roof of the house, powered by a five-volt battery connected to the edge of

the painting. The researchers also have demonstrated a flexible LED display on paper, conductive text and three-dimensional radio-frequency antennas.

Next, the researchers plan to expand the palette of inks to enable pen-on-paper writing of other electronic and ionically conductive materials.

The U.S. Department of Energy supported this work. Co-authors were graduate student Analisa Russo and postdoctoral researchers Bok Yeop Ahn, Jacob Adams and Eric Duoss.

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Journal Reference:

1. Analisa Russo, Bok Yeop Ahn, Jacob J. Adams, Eric B. Duoss, Jennifer T. Bernhard, Jennifer A. Lewis. **Pen-on-Paper Flexible Electronics**. *Advanced Materials*, 2011; DOI: 10.1002/adma.201101328

http://www.sciencedaily.com/releases/2011/06/110628151632.htm

Mars rover reaches rim of vast, ancient crater

- 10 August 2011 by **David Shiga**

On the edge (Image: NASA/JPL-Caltech/Cornell/ASU)

THREE years of trundling across treacherous dunes has brought NASA's Opportunity rover to its most significant target yet - a huge crater called Endeavour that was once soaked with water and could hold clues as to whether there was ever life on Mars.

Orbital observations suggest the rocks on Endeavour's rim are more than 3.5 billion years old and so date from the earliest, wettest phase of Martian history, when water carved out vast drainage channels across the planet. Until now, neither Opportunity nor its now-defunct sister Spirit (see "The rovers at a glance") had examined rocks that clearly date from this period.

"This is potentially the most exciting scientific opportunity for the rover mission yet," says John Callas, mission manager at NASA's Jet Propulsion Laboratory in Pasadena, California. That's because mineralogical studies from orbit suggest these ancient rocks formed in a cosy environment for life.

The rovers have previously studied rocks that were once immersed in acidic, salty water (see "Blueberry bonanza"). The 20-kilometre Endeavour, by contrast, seems to have harboured water friendlier to life, since

the crater contains clay minerals that require a relatively neutral pH to form. What's more, orbital measurements do not indicate that the ancient water was salty - though salty water may be flowing on Mars today (see "Dark streaks point to salty flows").

Opportunity's arrival at Endeavour marks a huge milestone for the mission. The goal seemed "almost unbelievably audacious" when it started heading there, says James Wray of the Georgia Institute of Technology in Atlanta.

The rover was only designed to last three months and in 2008, when it set out from a smaller crater called Victoria, it had already been on Mars for more than four years (see its route here). "I have gained a wife, lost a grandfather and moved twice [since then]," Wray says. "From that perspective, it does feel like a lot of time has passed."

The rover might reveal what form the water at Endeavour took. If it finds rocks bearing the imprint of ripples, that would suggest that water pooled on the surface, while if it spots rocks threaded with veins of clay minerals, that would point to water percolating underground, Wray says.

Opportunity entered Victoria crater but is likely to spend all its time at Endeavour on the rim. Endeavour's interior is less enticing because sediment from a later, drier period of Martian history has buried the old rocks there.

If it is still functioning a few years from now, the rover could set off for another, smaller crater called Iazu, with rocks that are just as old. "But holy smoly, that's like 15 kilometres away," nearly as far as the three-year trek to Endeavour, says Ray Arvidson of Washington University in St Louis, Missouri. He is content to see Opportunity live out the rest of its days scrutinising rocks and capturing eye-popping vistas on Endeavour's rim. "That's a spectacular way to end the mission," he says.

Blueberry bonanza

Almost immediately after it landed in 2004 in a region of Mars called Meridiani Planum, Opportunity made a watershed discovery: rocks at its landing site had formed in ancient lakes.

The evidence came in part from tiny "blueberries" (see image) made of haematite, which almost always forms in water. Curved lines of sediment pointed to the sweeping motion of a water current, while sulphate salts and the mineral jarosite, which forms in dilute sulphuric acid on Earth, suggested that the water was briny and acidic.

Dark streaks point to salty flows

Mars's image as a dust bowl may need a makeover. Dark streaks seen forming in summer and fading in winter might be signs of water flowing just beneath the surface (see image).

The appearance of streaks on sloping ground, including light streaks seen by NASA's Mars Global Surveyor spacecraft, has been attributed to present-day liquid water. But the link is not watertight - avalanches of dust could also be to blame.

Now, NASA's Mars Reconnaissance Orbiter (MRO) has revealed a previously unknown group of seasonal dark streaks in Mars's southern hemisphere that may be caused by flowing water. Alfred McEwen of the University of Arizona, Tucson, and colleagues found slopes where dark streaks appear every spring and disappear each winter (*Science*, DOI: 10.1126/science.1204816).

The seasonal streaks, which the team call recurring slope lineae, show no preference for dusty areas, where dust avalanches would be more likely. They are, however, found where radar observations show evidence for underground glaciers.

One possibility is that they result from meltwater that drains down slopes when ice thaws in the spring. But the researchers believe any flowing water lies below the surface - if it were above, MRO probably would have spotted its spectral signature, they say.

Some of the streaks form at -23 °C, well below the freezing point of pure water. Salty water, however, can remain liquid at such temperatures, and if it is flowing just beneath the surface, it might shift dust grains above, causing the dark streaks. "The best explanation we have for these observations so far is flow of briny water, although this study does not prove that," says McEwen.

The discovery of what might be liquid water on present-day Mars raises the possibility that life may have a toehold there. "It is our first chance to see an environment on Mars that might allow for the expression of an active biological process," says Lisa Pratt of Indiana University in Bloomington.

http://www.newscientist.com/article/mg21128254.100-mars-rover-reaches-rim-of-vast-ancient-crater.html

Universe's Most Distant Quasar Found, Powered by Massive Black Hole

This artist's impression shows how ULAS J1120+0641, a very distant quasar powered by a black hole with a mass two billion times that of the Sun, may have looked. This quasar is the most distant yet found and is seen as it was just 770 million years after the Big Bang. This object is by far the brightest object yet discovered in the early Universe. (Credit: ESO/M. Kornmesser)

ScienceDaily (June 29, 2011) — A team of European astronomers has used the European Southern Observatory's Very Large Telescope and a host of other telescopes to discover and study the most distant quasar found to date. This brilliant beacon, powered by a black hole with a mass two billion times that of the Sun, is by far the brightest object yet discovered in the early Universe. The results will appear in the June 30, 2011, issue of the journal Nature.

"This quasar is a vital probe of the early Universe. It is a very rare object that will help us to understand how supermassive black holes grew a few hundred million years after the Big Bang," says Stephen Warren, the study's team leader.

Quasars are very bright, distant galaxies that are believed to be powered by supermassive black holes at their centres. Their brilliance makes them powerful beacons that may help to probe the era when the first stars and galaxies were forming. The newly discovered quasar is so far away that its light probes the last part of the reionisation era [1].

The quasar that has just been found, named ULAS J1120+0641 [2], is seen as it was only 770 million years after the Big Bang (redshift 7.1, [3]). It took 12.9 billion years for its light to reach us.

Although more distant objects have been confirmed (such as a gamma-ray burst at redshift 8.2 and a galaxy at redshift 8.6), the newly discovered quasar is hundreds of times brighter than these. Amongst objects bright enough to be studied in detail, this is the most distant by a large margin.

The next most-distant quasar is seen as it was 870 million years after the Big Bang (redshift 6.4). Similar objects further away cannot be found in visible-light surveys because their light, stretched by the expansion of the Universe, falls mostly in the infrared part of the spectrum by the time it gets to Earth. The European UKIRT Infrared Deep Sky Survey (UKIDSS) which uses the UK's dedicated infrared telescope [4] in Hawaii was designed to solve this problem. The team of astronomers hunted through millions of objects in the UKIDSS database to find those that could be the long-sought distant quasars, and eventually struck gold.

"It took us five years to find this object," explains Bram Venemans, one of the authors of the study. "We were looking for a quasar with redshift higher than 6.5. Finding one that is this far away, at a redshift higher than 7, was an exciting surprise. By peering deep into the reionisation era, this quasar provides a unique opportunity to explore a 100-million-year window in the history of the cosmos that was previously out of reach."

The distance to the quasar was determined from observations made with the FORS2 instrument on ESO's Very Large Telescope (VLT) and instruments on the Gemini North Telescope [5]. Because the object is comparatively bright it is possible to take a spectrum of it (which involves splitting the light from the object into its component colours). This technique allowed the astronomers to find out quite a lot about the quasar.

These observations showed that the mass of the black hole at the centre of ULAS J1120+0641 is about two billion times that of the Sun. This very high mass is hard to explain so early on after the Big Bang. Current theories for the growth of supermassive black holes predict a slow build-up in mass as the compact object pulls in matter from its surroundings.

"We think there are only about 100 bright quasars with redshift higher than 7 over the whole sky," concludes Daniel Mortlock, the leading author of the paper. "Finding this object required a painstaking search, but it was worth the effort to be able to unravel some of the mysteries of the early Universe."

Notes

[1] About 300 000 years after the Big Bang, which occurred 13.7 billion years ago, the Universe had cooled down enough to allow electrons and protons to combine into neutral hydrogen (a gas without electric charge). This cool dark gas permeated the Universe until the first stars started forming about 100 to 150 million years later. Their intense ultraviolet radiation slowly split the hydrogen atoms back into protons and electrons, a process called reionisation, making the Universe more transparent to ultraviolet light. It is believe that this era occurred between about 150 million to 800 million years after the Big Bang.

[2] The object was found using data from the UKIDSS Large Area Survey, or ULAS. The numbers and prefix 'J' refer to the quasar's position in the sky.

[3] Because light travels at a finite speed, astronomers look back in time as they look further away into the Universe. It took 12.9 billion years for the light from ULAS J1120+0641 to travel to telescopes on Earth so the quasar is seen as it was when the Universe was only 770 million years old. In those 12.9 billion years, the Universe expanded and the light from the object stretched as a result. The cosmological redshift, or simply redshift, is a measure of the total stretching the Universe underwent between the moment when the light was emitted and the time when it was received.

[4] UKIRT is the United Kingdom Infrared Telescope. It is owned by the UK's Science and Technology Facilities Council and operated by the staff of the Joint Astronomy Centre in Hilo, Hawaii.

[5] FORS2 is the VLT's FOcal Reducer and low dispersion Spectrograph. Other instruments used to split up the light of the object were the Gemini Multi-Object Spectrograph (GMOS) and the Gemini Near-Infrared

Spectrograph (GNIRS). The Liverpool Telescope, the Isaac Newton Telescope and the UK Infrared Telescope (UKIRT) were also used to confirm survey measurements.

More information

This research was presented in a paper to appear in the journal *Nature* on 30 June 2011.

The team is composed of Daniel J. Mortlock (Imperial College London [Imperial], UK), Stephen J. Warren (Imperial), Bram P. Venemans (ESO, Garching, Germany), Mitesh Patel (Imperial), Paul C. Hewett (Institute of Astronomy [IoA], Cambridge, UK), Richard G. McMahon (IoA), Chris Simpson (Liverpool John Moores University, UK), Tom Theuns (Institute for Computational Cosmology, Durham, UK and University of Antwerp, Belgium), Eduardo A. Gonzales-Solares (IoA), Andy Adamson (Joint Astronomy Centre, Hilo, USA), Simon Dye (Centre for Astronomy and Particle Theory, Nottingham, UK), Nigel C. Hambly (Institute for Astronomy, Edinburgh, UK), Paul Hirst (Gemini Observatory, Hilo, USA), Mike J. Irwin (IoA), Ernst Kuiper (Leiden Observatory, The Netherlands), Andy Lawrence (Institute for Astronomy, Edinburgh, UK), Huub J. A. Rottgering (Leiden Observatory, The Netherlands).

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Beyond space-time: Welcome to phase space

- 08 August 2011 by **Amanda Gefter**

Magazine issue 2824.

Does some deeper level of reality lurk beneath? (Image: Luke Brookes)

A theory of reality beyond Einstein's universe is taking shape – and a mysterious cosmic signal could soon fill in the blanks

IT WASN'T so long ago we thought space and time were the absolute and unchanging scaffolding of the universe. Then along came Albert Einstein, who showed that different observers can disagree about the length of objects and the timing of events. His theory of relativity unified space and time into a single entity - space-time. It meant the way we thought about the fabric of reality would never be the same again. "Henceforth space by itself, and time by itself, are doomed to fade into mere shadows," declared mathematician Hermann Minkowski. "Only a kind of union of the two will preserve an independent reality."

But did Einstein's revolution go far enough? Physicist Lee Smolin at the Perimeter Institute for Theoretical Physics in Waterloo, Ontario, Canada, doesn't think so. He and a trio of colleagues are aiming to take relativity to a whole new level, and they have space-time in their sights. They say we need to forget about the home Einstein invented for us: we live instead in a place called phase space.

If this radical claim is true, it could solve a troubling paradox about black holes that has stumped physicists for decades. What's more, it could set them on the path towards their heart's desire: a "theory of everything" that will finally unite general relativity and quantum mechanics.

So what is phase space? It is a curious eight-dimensional world that merges our familiar four dimensions of space and time and a four-dimensional world called momentum space.

Momentum space isn't as alien as it first sounds. When you look at the world around you, says Smolin, you don't ever observe space or time - instead you see energy and momentum. When you look at your watch, for example, photons bounce off a surface and land on your retina. By detecting the energy and momentum of the photons, your brain reconstructs events in space and time.

The same is true of physics experiments. Inside particle smashers, physicists measure the energy and momentum of particles as they speed toward one another and collide, and the energy and momentum of the debris that comes flying out. Likewise, telescopes measure the energy and momentum of photons streaming in from the far reaches of the universe. "If you go by what we observe, we don't live in space-time," Smolin says. "We live in momentum space."

And just as space-time can be pictured as a coordinate system with time on one axis and space - its three dimensions condensed to one - on the other axis, the same is true of momentum space. In this case energy is on one axis and momentum - which, like space, has three components - is on the other (see diagram).

Simple mathematical transformations exist to translate measurements in this momentum space into measurements in space-time, and the common wisdom is that momentum space is a mere mathematical tool. After all, Einstein showed that space-time is reality's true arena, in which the dramas of the cosmos are played out.

Smolin and his colleagues aren't the first to wonder whether that is the full story. As far back as 1938, the German physicist Max Born noticed that several pivotal equations in quantum mechanics remain the same whether expressed in space-time coordinates or in momentum space coordinates. He wondered whether it might be possible to use this connection to unite the seemingly incompatible theories of general relativity, which deals with space-time, and quantum mechanics, whose particles have momentum and energy. Maybe it could provide the key to the long-sought theory of quantum gravity.

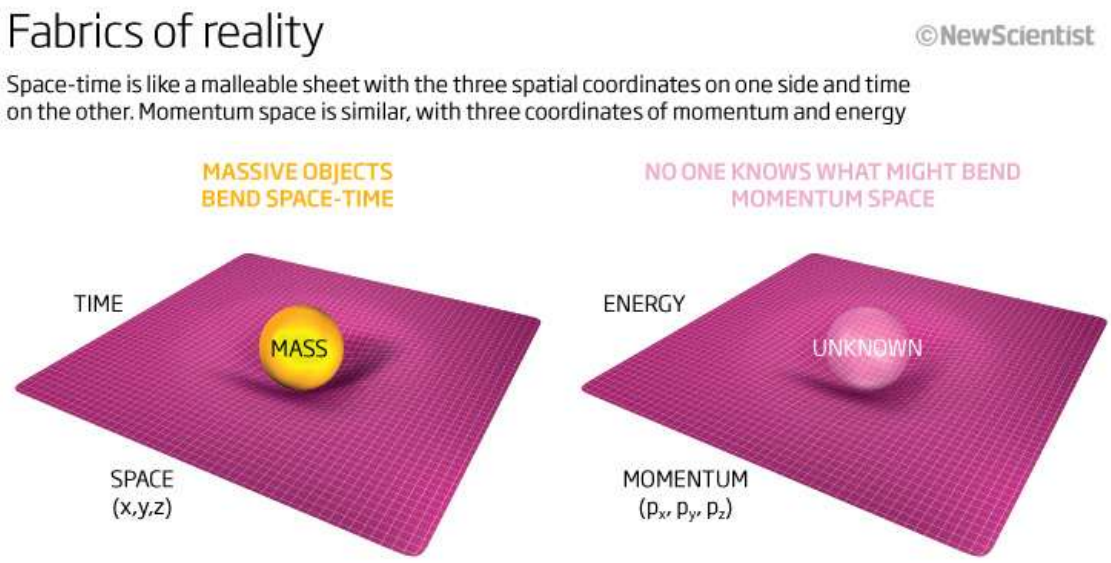
Born's idea that space-time and momentum space should be interchangeable - a theory now known as "Born reciprocity" - had a remarkable consequence: if space-time can be curved by the masses of stars and galaxies, as Einstein's theory showed, then it should be possible to curve momentum space too.

At the time it was not clear what kind of physical entity might curve momentum space, and the mathematics necessary to make such an idea work hadn't even been invented. So Born never fulfilled his dream of putting space-time and momentum space on an equal footing.

That is where Smolin and his colleagues enter the story. Together with Laurent Freidel, also at the Perimeter Institute, Jerzy Kowalski-Glikman at the University of Wroclaw, Poland, and Giovanni Amelino-Camelia at Sapienza University of Rome in Italy, Smolin has been investigating the effects of a curvature of momentum space.

The quartet took the standard mathematical rules for translating between momentum space and space-time and applied them to a curved momentum space. What they discovered is shocking: observers living in a curved momentum space will no longer agree on measurements made in a unified space-time. That goes entirely against the grain of Einstein's relativity. He had shown that while space and time were relative, space-

time was the same for everyone. For observers in a curved momentum space, however, even space-time is relative (see diagram).



This mismatch between one observer's space-time measurements and another's grows with distance or over time, which means that while space-time in your immediate vicinity will always be sharply defined, objects and events in the far distance become fuzzier. "The further away you are and the more energy is involved, the larger the event seems to spread out in space-time," says Smolin.

For instance, if you are 10 billion light years from a supernova and the energy of its light is about 10 gigaelectronvolts, then your measurement of its location in space-time would differ from a local observer's by a light second. That may not sound like much, but it amounts to 300,000 kilometres. Neither of you would be wrong - it's just that locations in space-time are relative, a phenomenon the researchers have dubbed "relative locality".

Relative locality would deal a huge blow to our picture of reality. If space-time is no longer an invariant backdrop of the universe on which all observers can agree, in what sense can it be considered the true fabric of reality?

That is a question still to be wrestled with, but relative locality has its benefits, too. For one thing, it could shed light on a stubborn puzzle known as the black hole information-loss paradox. In the 1970s, Stephen Hawking discovered that black holes radiate away their mass, eventually evaporating and disappearing altogether. That posed an intriguing question: what happens to all the stuff that fell into the black hole in the first place?

Relativity prevents anything that falls into a black hole from escaping, because it would have to travel faster than light to do so - a cosmic speed limit that is strictly enforced. But quantum mechanics enforces its own strict law: things, or more precisely the information that they contain, cannot simply vanish from reality. Black hole evaporation put physicists between a rock and a hard place.

According to Smolin, relative locality saves the day. Let's say you were patient enough to wait around while a black hole evaporated, a process that could take billions of years. Once it had vanished, you could ask what

happened to, say, an elephant that once succumbed to its gravitational grip. But as you look back to the time at which you thought the elephant had fallen in, you would find that locations in space-time had grown so fuzzy and uncertain that there would be no way to tell whether the elephant actually fell into the black hole or narrowly missed it. The information-loss paradox dissolves.

Big questions still remain. For instance, how can we know if momentum space is really curved? To find the answer, the team has proposed several experiments.

One idea is to look at light arriving at the Earth from distant gamma-ray bursts. If momentum space is curved in a particular way that mathematicians refer to as "non-metric", then a high-energy photon in the gamma-ray burst should arrive at our telescope a little later than a lower-energy photon from the same burst, despite the two being emitted at the same time.

Just that phenomenon has already been seen, starting with some unusual observations made by a telescope in the Canary Islands in 2005 (*New Scientist*, 15 August 2009, p 29). The effect has since been confirmed by NASA's Fermi gamma-ray space telescope, which has been collecting light from cosmic explosions since it launched in 2008. "The Fermi data show that it is an undeniable experimental fact that there is a correlation between arrival time and energy - high-energy photons arrive later than low-energy photons," says Amelino-Camelia.

Still, he is not popping the champagne just yet. It is not clear whether the observed delays are true signatures of curved momentum space, or whether they are down to "unknown properties of the explosions themselves", as Amelino-Camelia puts it. Calculations of gamma-ray bursts idealise the explosions as instantaneous, but in reality they last for several seconds. While there is no obvious reason to think so, it is possible that the bursts occur in such a way that they emit lower-energy photons a second or two before higher-energy photons, which would account for the observed delays.

In order to disentangle the properties of the explosions from properties of relative locality, we need a large sample of gamma-ray bursts taking place at various known distances (arxiv.org/abs/1103.5626). If the delay is a property of the explosion, its length will not depend on how far away the burst is from our telescope; if it is a sign of relative locality, it will. Amelino-Camelia and the rest of Smolin's team are now anxiously awaiting more data from Fermi.

The questions don't end there, however. Even if Fermi's observations confirm that momentum space is curved, they still won't tell us what is doing the curving. In general relativity, it is momentum and energy in the form of mass that warp space-time. In a world in which momentum space is fundamental, could space and time somehow be responsible for curving momentum space?

Work by Shahn Majid, a mathematical physicist at Queen Mary University of London, might hold some clues. In the 1990s, he showed that curved momentum space is equivalent to what's known as a noncommutative space-time. In familiar space-time, coordinates commute - that is, if we want to reach the point with coordinates (x,y), it doesn't matter whether we take x steps to the right and then y steps forward, or if we travel y steps forward followed by x steps to the right. But mathematicians can construct space-times in which this order no longer holds, leaving space-time with an inherent fuzziness.

In a sense, such fuzziness is exactly what you might expect once quantum effects take hold. What makes quantum mechanics different from ordinary mechanics is Heisenberg's uncertainty principle: when you fix a particle's momentum - by measuring it, for example - then its position becomes completely uncertain, and vice versa. The order in which you measure position and momentum determines their values; in other words, these properties do not commute. This, Majid says, implies that curved momentum space is just quantum space-time in another guise.

What's more, Majid suspects that this relationship between curvature and quantum uncertainty works two ways: the curvature of space-time - a manifestation of gravity in Einstein's relativity - implies that momentum space is also quantum. Smolin and colleagues' model does not yet include gravity, but once it does, Majid says, observers will not agree on measurements in momentum space either. So if both space-time and momentum space are relative, where does objective reality lie? What is the true fabric of reality?

Smolin's hunch is that we will find ourselves in a place where space-time and momentum space meet: an eight-dimensional phase space that represents all possible values of position, time, energy and momentum. In relativity, what one observer views as space, another views as time and vice versa, because ultimately they are two sides of a single coin - a unified space-time. Likewise, in Smolin's picture of quantum gravity, what one observer sees as space-time another sees as momentum space, and the two are unified in a higher-dimensional phase space that is absolute and invariant to all observers. With relativity bumped up another level, it will be goodbye to both space-time and momentum space, and hello phase space.

"It has been obvious for a long time that the separation between space-time and energy-momentum is misleading when dealing with quantum gravity," says physicist João Magueijo of Imperial College London. In ordinary physics, it is easy enough to treat space-time and momentum space as separate things, he explains, "but quantum gravity may require their complete entanglement". Once we figure out how the puzzle pieces of space-time and momentum space fit together, Born's dream will finally be realised and the true scaffolding of reality will be revealed.

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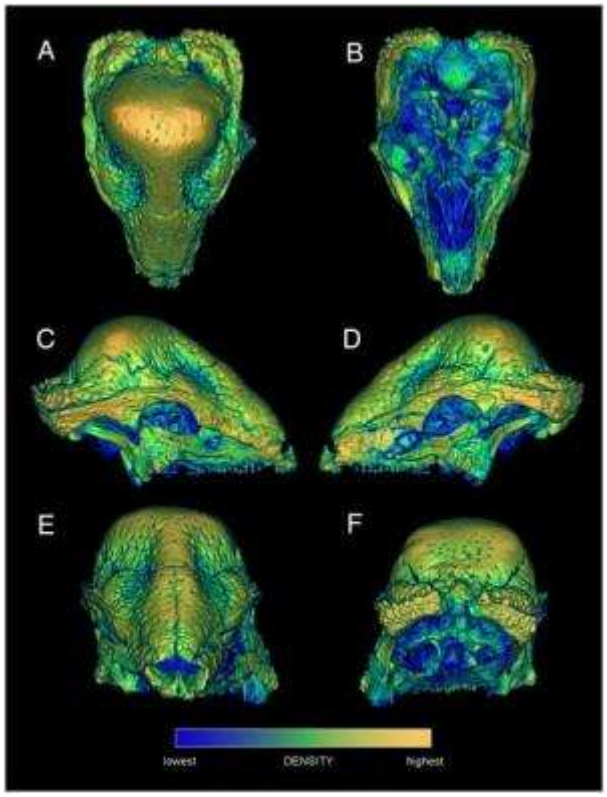
***Amanda Gefter** is a consultant for New Scientist based in Boston*

http://www.newscientist.com/article/mg21128241.700-beyond-spacetime-welcome-to-phase-space.html

Domed Dinosaur Was King of the Head Butt



Relative surface densities of cranial bone in Stegoceras validum (UA 2): External densities of the cranium of Stegoceras validum, in dorsal (A), ventral (B), lateral (C, D), anterior (E) and posterior (F) views. Note high densities of cranial ornamentation, and numerous neurovascular canals (correlates of a keratinous pad) exiting onto the cranial roof. (Credit: Eric Snively, Jessica M. Theodor. Common Functional Correlates of Head-Strike Behavior in the Pachycephalosaur Stegoceras validum (Ornithischia, Dinosauria) and Combative Artiodactyls. PLoS ONE, 2011; 6 (6): e21422 DOI: 10.1371/journal.pone.0021422)

ScienceDaily (June 29, 2011) — Llamas can't really manage it. Giraffes aren't very good at it and while big horn sheep and muskox excel at it, it turns out a small plant eating dinosaur -- the pachycephalosaur *Stegoceras validum* -- was probably even better at it: head butting.

Researchers surveyed the heads of a large number of modern animals as well as one of the world's best dinosaur fossils, the *Stegoceras* specimen from the University of Alberta. They found that the bony anatomy of some pachycephalosaur domes are better at protecting the brain than in any modern head butter. The results of their research is published in *PLoS ONE*.

"Pachycephalosaur domes are weird structures not exactly like anything in modern animals. We wanted to test the controversial idea that the domes were good for head butting," says co-author Dr. Eric Snively, University of Calgary alumnus and post-doctoral researcher in biomedical engineering at Ohio University.

"Finding out brings us closer to their social lives: were pachycephalosaurs more likely just showing off their domes like peacocks with their tails, or were they also cracking their heads together like musk oxen?"

Using CT scanning and a new statistical method for diagnosing behavior in fossil animals, the researchers compared the bony-headed dinosaur with modern ungulates (hoofed animals) that engage in different kinds of combat.

"Our analyses are the closest we can get to observing their behavior. In a way, we can get "inside their heads" by colliding them together virtually. We combined anatomical and engineering analyses of all these animals for a pretty thorough approach," says Snively. "We looked at the actual tissue types in the skulls and heads of the animals."

Head butting is a form of male-to-male competition for access to females, says Dr. Jessica Theodor, co-author and associate professor in the biological sciences department at the University of Calgary. "It's pretty clear that although the bones are arranged differently in the *Stegoceras*, it could easily withstand the kinds of forces that have been measured for the living animals that engage in head butting."

Most head-butting animals have domes like a good motorcycle helmet. "They have a stiff rind on the outside with a sort of a spongy energy absorbing material just beneath it and then a stiff, really dense coat over the brain," says Snively. The *Stegoceras* had an extra layer of dense bone in the middle. *Stegoceras* was a small pachycephalosaur about the size of a German shepherd, and lived about 72 million years ago.

Llamas would crack their skulls head butting and giraffes aren't very good at it. "They swing their necks at each other and try to hit each other in the neck or the side," says Snively. If giraffes do manage to butt heads, they can knock each other out because "Their anatomy isn't built to absorb the collision as well as something like muskox or big horn sheep."

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Calgary**.

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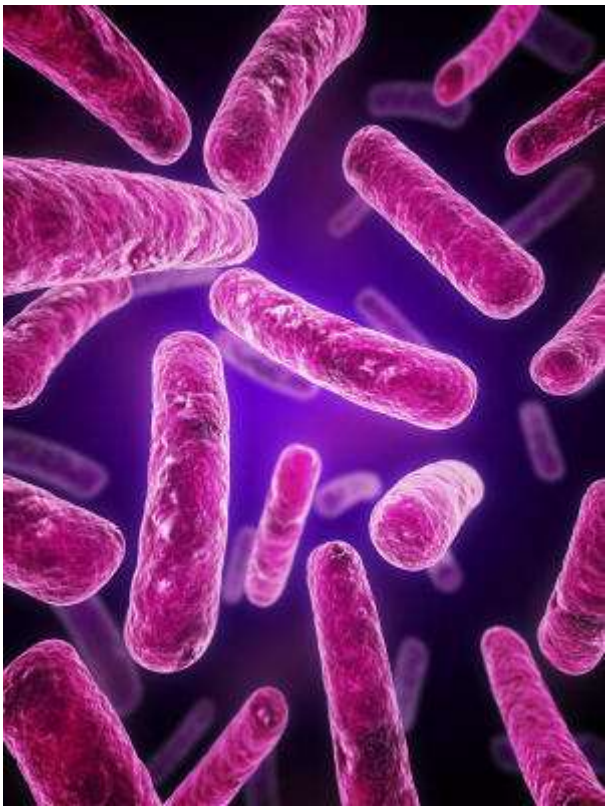
1. Eric Snively, Jessica M. Theodor. **Common Functional Correlates of Head-Strike Behavior in the Pachycephalosaur Stegoceras validum (Ornithischia, Dinosauria) and Combative Artiodactyls**. *PLoS ONE*, 2011; 6 (6): e21422 DOI: 10.1371/journal.pone.0021422

http://www.sciencedaily.com/releases/2011/06/110628173755.htm

Bacterium Engineered With DNA in Which Thymine Is Replaced by Synthetic Building Block



Artist's rendering of E. coli. (Credit: iStockphoto/Sebastian Kaulitzki)

ScienceDaily (June 29, 2011) — The genetic information of all living cells is stored in the DNA composed of the four canonical bases adenine (A), cytosine (C), guanine (G) and thymine (T). An international team of researchers has now succeeded in generating a bacterium possessing a DNA in which thymine is replaced by the synthetic building block 5-chlorouracil (c), a substance toxic for other organisms.

The project, coordinated by Rupert Mutzel (Institut für Biologie, Freie Universität Berlin) and Philippe Marlière (Heurisko USA Inc.), involved researchers of the French CEA (Commissariat à l'Energie Atomique et aux Energies Alternatives) and of the Katholieke Universiteit Leuven (Belgium). As described in the latest issue of *Angewandte Chemie International Edition*, the experimental work was based on a unique technology developed by Marlière and Mutzel enabling the directed evolution of organisms under strictly controlled conditions. Large populations of microbial cells are cultured for prolonged periods in the presence of a toxic chemical -- in this case, 5-chlorouracil -- at sublethal levels, thereby selecting for genetic variants capable of tolerating higher concentrations of the toxic substance.

In response to the appearance of such variants in the cell population the concentration of the toxic chemical in the growth medium is increased, thus keeping the selection pressure constant. This automated procedure of long term evolution was applied to adapt genetically engineered *Escherichia coli* bacteria unable to synthesize the natural nucleobase thymine to grow on increasing concentrations of 5-chlorouracil. After a culture period of about 1000 generations descendants of the original strain were obtained which used 5-chlorouracil as complete substitute for thymine. Subsequent genome analysis revealed numerous mutations in the DNA of the adapted bacteria. The contribution of these mutations to the adaptation of the cells towards the halogenated base will be the subject of follow-up studies.

Besides the obvious interest of this radical change in the chemistry of living systems for basic research the scientists consider the outcome of their work also to be of importance for "xenobiology," a branch of synthetic biology. This young area of the life sciences aims at the generation of new organisms not found in nature harboring metabolic traits optimized for alternative modes of energy production or for the synthesis of high value chemicals. Like GMOs, such organisms are seen as a potential threat for natural ecosystems when released from their laboratory confinements, either through direct competition with wild type organisms or through diffusion of their "synthetic" DNA.

Scientists have recognized that physical containment cannot in every single case prevent engineered live forms from reaching natural habitats, in the same way as radioactive isotopes can leak into the surroundings of a nuclear power plant. However, synthetic organisms like those evolved by Marlière and Mutzel and their collaborators which depend on the availability of substances for their proliferation not found in nature or which incorporate non-natural building blocks in their genetic material could neither compete nor exchange genetic messages with wild type organisms, but would die in the absence of the xenobiotic.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Freie Universitaet Berlin**, via AlphaGalileo.

Journal Reference:

1. Philippe Marlière, Julien Patrouix, Volker Döring, Piet Herdewijn, Sabine Tricot, Stéphane Cruveiller, Madeleine Bouzon, Rupert Mutzel. **Chemical Evolution of a Bacterium's Genome**. *Angewandte Chemie International Edition*, 2011; DOI: 10.1002/anie.201100535

http://www.sciencedaily.com/releases/2011/06/110628132438.htm

Existence: How will it all end?

- 05 August 2011 by **Stephen Battersby**

Magazine issue 2822

Dramatic ending (Image: Karl Weatherly/Getty)

IT IS three weeks after the end of time, and at the Post-Universe Conference of Cosmology and Other Loose Ends, Professor Adams is standing in front of a restless audience telling them in smug tones what they already know. The universe ended in precisely the way that his own theory predicted, in a rather uncomfortable event known as the "Big Slurp".

Of course, by definition there can be no such meeting and no way to prove or disprove a theory about the end of all things. But this untestable question tugs at our morbid curiosity. In recent years physicists have been peering deep into the tea leaves of time to try to foretell our ultimate fate. Will the universe be finished off by a big freeze, a big rip, a big crunch... or a big something else?

To make a first attempt at this long-range forecast, we can just extrapolate current trends. Today's universe is expanding, and the expansion is accelerating as the repulsive agent called dark energy takes hold. Projecting our ballooning universe into the future, we seem to be doomed to a dingy end. Most of known space will fly off into the darkness, isolating our local group of galaxies in its own lonely pocket universe. The stars will fade and eventually matter itself may fall apart as protons decay, leaving behind nothing but a wispy gas of fundamental particles, ever-more tenuous and ever colder.

Or it could be worse. We don't know what dark energy is, so we don't know whether it will remain constant into the distant future. The repulsion might get stronger as space expands. If this growing "phantom energy" really gets going, the eventual end will come in a split second of cosmic violence called the big rip, as planets, molecules and finally subatomic particles are shredded. Then again, some form of attractive cosmic force could arise to overpower today's repulsion and pull the galaxies back together again, crushing everything to a point of infinite density - a big crunch.

Fortunately, neither of these violent ends will happen any time soon. Observations show that dark energy is changing slowly if at all, implying that a big rip or big crunch is probably tens of billions of years away at least.

An even more disquieting possibility could be just around the corner, however. The very nature of space-time may be unstable. According to string theory, for example, the vacuum of space seems to be free to adopt any of a bewildering variety of different states, which would support different kinds of forces and particles, even different numbers of dimensions. Our apparently firm reality might suddenly decay into a state with lower energy. The foundations of our existence would suddenly be yanked from under us and we, along with any familiar forms of matter, would cease to exist.

Transmogrification

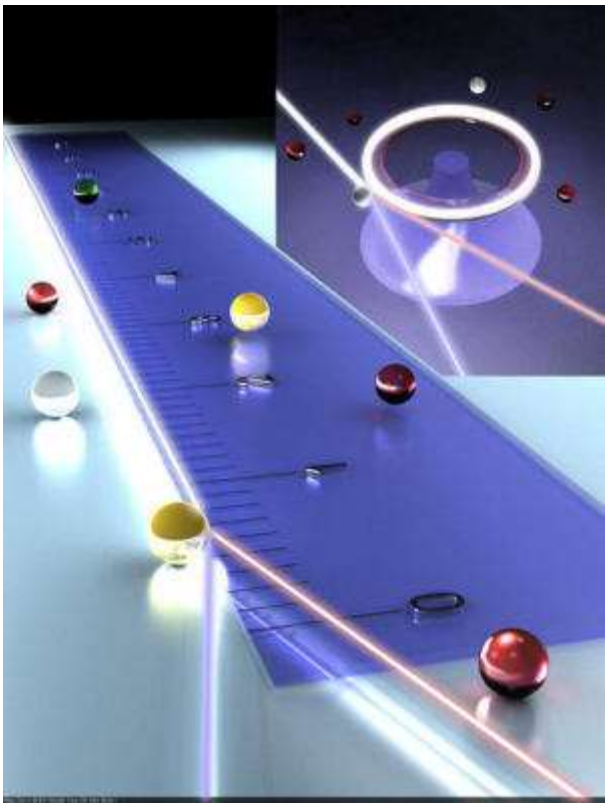
If the vacuum does decay, it will happen at some point in space first, and then race outwards in a spherical shock-front of grisly transmogrification travelling at just a tiny fraction less than the speed of light. In theory we would get some warning of approaching doom, but not a lot. "Much less than a microsecond," says cosmologist Alexander Vilenkin of Tufts University in Medford, Massachusetts. At this very moment a wave of ultimate weirdness might be turning the moon into ectoplasm and bearing down on Earth.

Vilenkin thinks that such an end is almost inevitable; that unless a big rip gets us first, the vacuum will eventually drop into a negative energy state. After the transformation, space would then exert strong gravity of its own, pulling what's left of the universe into a big crunch.

That, however, need not be the end of everything. If our own universe is merely one within an ever-branching and growing multiverse, as some theories predict, then the cosmos as a whole will endure even if each of its branches has a limited lifespan. And for our local universe there remains the hope of resurrection. Today's physical theories break down at a big crunch or a big rip, allowing the possibility that a new universe could rise from the ashes (in a big bounce, or some other big as-yet-unnamed thing). And in the case of a big freeze, there will be so much time to play with that a random quantum fluctuation might spark a whole new big bang. Perhaps that impossible cosmology conference could happen after all. Perhaps existence will never end.

http://www.newscientist.com/article/mg21128222.300-existence-how-will-it-all-end.html

Tiny Ring Laser Accurately Detects and Counts Nanoparticles



Whispering-gallery microlasers can count and measure nano-scale synthetic or biological particles. As this conceptual illustration shows, a particle disturbs the lasing "mode" to split into two frequencies (shown here as two different colors) and the frequency split acts a ruler that allows the particle to be measured. The inset at the top right shows a particle landing on the microlaser (a torus supported by a pedestal). Lina He, a graduate student in electrical and systems engineering at Washington University in St. Louis, and her co-workers demonstrated that the microlasers can detect particles 10 nanometers in radius. Their resolution limit is about one nanometer. (Credit: J. Zhu, L. He, S. K. Ozdemir, and L. Yang/WUSTL)

ScienceDaily (June 29, 2011) — A tiny doughnut-shaped laser is the latest marvel of silicon microminiaturization, but instead of manipulating bits it detects very small particles. Small particles play a big -- and largely unnoticed -- role in our everyday lives. Virus particles make us sick, salt particles trigger cloud formation, and soot particles sift deep into our lungs and make it harder to breathe.

The sensor belongs to a category called whispering gallery resonators, which work like the famous whispering gallery in St. Paul's Cathedral in London, where someone on the one side of the dome can hear a message spoken to the wall by someone on the other side. Unlike the dome, which has resonances or sweet spots in the audible range, the sensor resonates at light frequencies.

Light traveling round the micro-laser is disturbed by a particle that lands on the ring, changing the light's frequency. The ring can count the touch-down of as many as 800 nanoparticles before the signals begin to be lost in the noise. By exciting more than one mode in the ring, scientists can double-check the accuracy of the count. And by changing the "gain medium," they can adapt the sensor for water rather than air.

Lan Yang, PhD, assistant professor of electrical and systems engineering at Washington University in St. Louis who leads the team that fabricated the new sensor, says that there is already lively interest in its commercialization in fields ranging from biology to aerosol science. The sensor is described and characterized in the June 26 online edition of *Nature Nanotechnology*.

Whispering gallery resonator becomes microlaser

A whispering gallery resonator supports "frequency degenerate modes" (modes, or patterns of excitation in the ring, with the same frequency, one traveling clockwise and the other counterclockwise around the ring.

The mode fields have "evanescent tails" that penetrate the surface of the ring and probe the surrounding medium. When a particle lands on one of the "hot spots" it scatters energy from one of the modes into the other, and the modes adopt slightly different resonance frequencies. This is referred to as mode splitting.

In an earlier work, Yang team used mode splitting in a simple glass ring that functioned as a waveguide for light coupled into it from outside. Because the ring was passive, the external-laser had to be an expensive tunable laser so that it could scan a frequency range looking for the ring's resonances to measure mode splitting. (For more information on this sensor see "Tiny sensor takes measure of nanoparticles.")

The new sensor differs from earlier whispering gallery resonators in that it is itself a miniature laser rather than the resonating cavity of an external laser.

The new sensor is also glass but glass laced with atoms of the rare earth elements that serve as a "gain medium." The glass is doped with rare-earth atoms and when an external light source boosts enough of them into an excited state, the ring begins to lase at its own preferred frequency.

When a particle lands on the microlaser, a single lasing line splits into two slightly different frequencies.

A simple way of measuring the frequency splitting is to mix the split laser modes in a photodetector, which produces a "beat frequency" that corresponds to the frequency difference.

"The tiny sensors are mass produced by sol-gel method on silicon wafer, and it is easy to switch the gain medium" says Lina He, a graduate student and first author of the paper. "The resonators are made by mixing the rare-earth ions of choice into a solution of tetraethoxysilane, water and hydrochloric acid. The solution is heated until it becomes viscous and then spin-coated on a silicon wafer and annealed to remove solvents and complete the transition to amorphous glass. The thin film of glass is then etched to create silica disks supported underneath by silicon pillars. As a final step, the rough silica disks are reflowed into smooth toroids by laser annealing."

Active sensor outperforms passive one

"The light used for sensing is generated inside the resonator itself, and so it is purer than the light in the passive sensor," says Yang "When the light is not that pure, you might not be able to see small frequency changes. But the active sensor hits one frequency -- it has a really narrow linewidth -- and so it is much more sensitive."

The microlaser is orders of magnitude more sensitive than the passive resonator, she says. Its effective resolution limit is about one nanometer. One nanometer is to a meter, what a marble is to Earth.

Moreover, because the laser is now in the ring rather than coupled to it, the entire system is simpler and more self contained. "Now you just need a light source to excite the optical medium," says Yang, "and you can use a cheap laser diode for that instead of an expensive tunable laser."

Detecting many particles

The effect of a particle on a lasing mode depends on the particle's "polarizability," which is a function of its size and refractive index. To cover the possibilities, the Washington University team tested the micro-laser's performance with nanoparticles of various sizes made of various materials, including polystyrene (packing peanuts), virions (virus particles) and gold.

As particles enter the "mode volume" of the micro-laser one by one, the scientists can see a discrete upward or downward jump in the beat frequency. Each discrete jump signals the binding of a particle on the ring, and the number of the jumps reflects the number of particles.

Because the "resonator field" traps the particles on the resonator, once landed, they rarely drop off. But the team found they were able to count many particles before the losses induced by the particles made the laser linewidths so broad they couldn't detect changes in frequency splitting due to the latest arrival.

For example, they were able to detect and count as many as 816 gold nanoparticles using the same laser mode.

"When the line broadening is comparable to the change in splitting, then you're done," says Yang. "However, the whole resonator is fabricated on the chip, so you could just move on to the next resonator if necessary."

Doubling up for accuracy

The micro-laser can support more than one laser mode at a time. "By controlling the overlap of the pump light with the gain medium, you can excite more than one laser line," says Sahin Kaya Ozdemir, PhD, a research associate and co-author. "Then when a particle lands on the ring, each laser line will split into two, and generate a beat frequency. So you will have two beat frequencies instead of one."

That's an advantage, he explains, because the beat frequency depends in part on where the particle lands on the ring. If there is only one laser line and the particle falls between "hot spots" it might not be detected. The second beat frequency prevents these "false negatives," ensuring that every particle produces a detectable beat frequency.

Detecting particles in water

The microlasers intended to sense particles in air had been doped with erbium, a rare-earth element whose optical properties are well matched with those of air. In a final experiment designed to see whether this technique could be used to sense particles in water or blood, the team fabricated sensors that were doped with ytterbium rather than erbium.Ytterbium lases at wavelengths with low absorption of light by water

Yang's team has already begun working to make use of the enhanced sensitivity provided by the microlaser for studying various problems. In terms of applications, "the near-term use will be the monitoring of dynamic behaviors of particles in response to environmental and chemical changes at single particle resolution," says Yang.

The next step, the team see is to engineer the surface of these tiny microlasers to detect DNA and individual biological molecules. If the DNA is tagged with engineered nanoparticles, the micro-laser sensor can count individual DNA molecules or fragments of molecules.

Listening to Yang it is hard to escape the impression that you're hearing for the first time about an astonishing device that will one day be as ubiquitous -- and probably as underappreciated -- as the logic gates in our microwaves, cellphones and cars.

The Washington University in St. Louis team behind these results includes: L. He, W. Kim and J. Zhu, graduate students; S. K. Ozdemir, PhD, a research associate, and L. Yang, PhD, assistant professor in electrical and systems engineering.

This work is supported by National Science Foundation.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Washington University in St. Louis**. The original article was written by Diana Lutz.

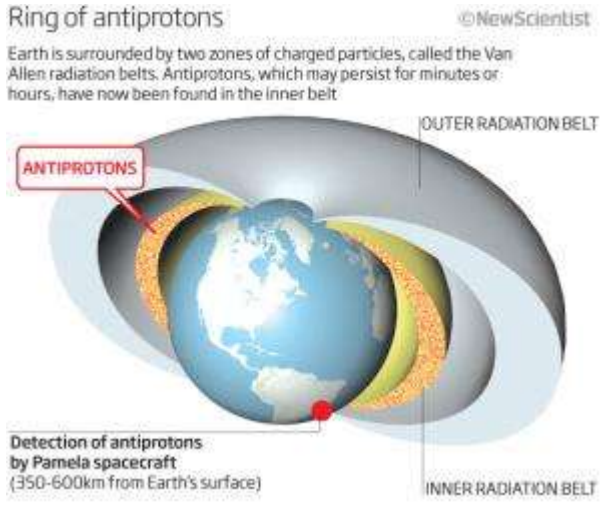
Journal Reference:

1. Lina He, Şahin Kaya Özdemir, Jiangang Zhu, Woosung Kim, Lan Yang. **Detecting single viruses and nanoparticles using whispering gallery microlasers**. *Nature Nanotechnology*, 2011; DOI: 10.1038/NNANO.2011.99

http://www.sciencedaily.com/releases/2011/06/110628113145.htm

Antiproton ring found around Earth

- 04 August 2011 by **Hazel Muir**
- Magazine issue 2824.



Ring of antiprotons

Enlarge image

ANTIPROTONS appear to ring the Earth, confined by the planet's magnetic field lines. The antimatter, which may persist for minutes or hours before annihilating with normal matter, could in theory be used to fuel ultra-efficient rockets of the future.

Charged particles called cosmic rays constantly rain in from space, creating a spray of new particles - including antiparticles - when they collide with particles in the atmosphere. Many of these become trapped inside the Van Allen radiation belts, two doughnut-shaped zones around the planet where charged particles spiral around the Earth's magnetic field lines.

Satellites had already discovered positrons - the antimatter partners of electrons - in the radiation belts. Now a spacecraft has detected antiprotons, which are nearly 2000 times as massive.

Heavier particles take wider paths when they spiral around the planet's magnetic lines, and weaker magnetic field lines also lead to wider spirals. So relatively heavy antiprotons travelling around the weak field lines in the outer radiation belt were expected to take loops so big they would quickly get pulled into the lower atmosphere, where they would annihilate with normal matter. The inner belt was thought to have fields strong enough to trap antiprotons, and indeed that is where they have been found.

Piergiorgio Picozza from the University of Rome Tor Vergata, Italy, and colleagues detected the antiprotons using PAMELA, a cosmic-ray detector attached to a Russian Earth-observation satellite. The spacecraft flies through the Earth's inner radiation belt over the south Atlantic.

Between July 2006 and December 2008, PAMELA detected 28 antiprotons trapped in spiralling orbits around the magnetic field lines sprouting from the Earth's south pole (*Astrophysical Journal Letters*, DOI: 10.1088/2041-8205/737/2/l29). PAMELA samples only a small part of the inner radiation belt, but

antiprotons are probably trapped throughout it. "We are talking about of billions of particles," says team member Francesco Cafagna from the University of Bari in Italy.

"I find it very interesting to note that the Earth's magnetic field works a little bit like the magnetic traps that we are using in the lab," says Rolf Landua at the CERN particle physics laboratory near Geneva, Switzerland. There, researchers have been trying to trap antimatter for ever longer periods to compare its behaviour with that of normal matter.

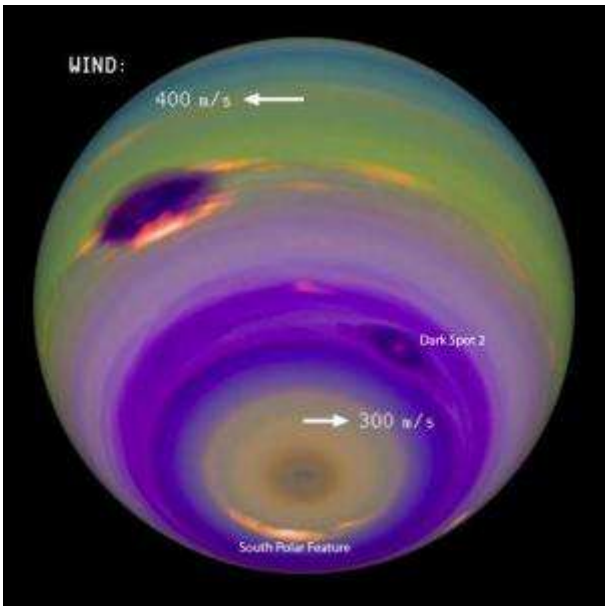
Alessandro Bruno, another team member from Bari, says antimatter in the Earth's radiation belts might one day be useful for fuelling spacecraft. Future rockets could be powered by the reaction between matter and antimatter, a reaction that produces energy even more efficiently than nuclear fusion in the sun's core.

"This is the most abundant source of antiprotons near the Earth," says Bruno. "Who knows, one day a spacecraft could launch then refuel in the inner radiation belt before travelling further."

Millions or billions of times as many antiprotons probably ring the giant planets.

http://www.newscientist.com/article/mg21128245.500-antiproton-ring-found-around-earth.html

Clocking Neptune's Spin



In this image, the colors and contrasts were modified to emphasize the planet's atmospheric features. The winds in Neptune's atmosphere can reach the speed of sound or more. Neptune's Great Dark Spot stands out as the most prominent feature on the left. Several features, including the fainter Dark Spot 2 and the South Polar Feature, are locked to the planet's rotation, which allowed Karkoschka to precisely determine how long a day lasts on Neptune. (Credit: Erich Karkoschka)

ScienceDaily (June 29, 2011) — A day on Neptune lasts precisely 15 hours, 57 minutes and 59 seconds, according to the first accurate measurement of its rotational period made by University of Arizona planetary scientist Erich Karkoschka.

His result is one of the largest improvements in determining the rotational period of a gas planet in almost 350 years since Italian astronomer Giovanni Cassini made the first observations of Jupiter's Red Spot.

"The rotational period of a planet is one of its fundamental properties," said Karkoschka, a senior staff scientist at the UA's Lunar and Planetary Laboratory. "Neptune has two features observable with the Hubble Space Telescope that seem to track the interior rotation of the planet. Nothing similar has been seen before on any of the four giant planets."

The discovery is published in *Icarus*, the official scientific publication of the Division for Planetary Sciences of the American Astronomical Society.

Unlike the rocky planets -- Mercury, Venus, Earth and Mars -- which behave like solid balls spinning in a rather straightforward manner, the giant gas planets -- Jupiter, Saturn, Uranus and Neptune -- rotate more like giant blobs of liquid. Since they are believed to consist of mainly ice and gas around a relatively small solid core, their rotation involves a lot of sloshing, swirling and roiling, which has made it difficult for astronomers to get an accurate grip on exactly how fast they spin around.

"If you looked at Earth from space, you'd see mountains and other features on the ground rotating with great regularity, but if you looked at the clouds, they wouldn't because the winds change all the time," Karkoschka explained. "If you look at the giant planets, you don't see a surface, just a thick cloudy atmosphere."

"On Neptune, all you see is moving clouds and features in the planet's atmosphere. Some move faster, some move slower, some accelerate, but you really don't know what the rotational period is, if there even is some solid inner core that is rotating."

In the 1950s, when astronomers built the first radio telescopes, they discovered that Jupiter sends out pulsating radio beams, like a lighthouse in space. Those signals originate from a magnetic field generated by the rotation of the planet's inner core.

No clues about the rotation of the other gas giants, however, were available because any radio signals they may emit are being swept out into space by the solar wind and never reach Earth.

"The only way to measure radio waves is to send spacecraft to those planets," Karkoschka said. "When Voyager 1 and 2 flew past Saturn, they found radio signals and clocked them at exactly 10.66 hours, and they found radio signals for Uranus and Neptune as well. So based on those radio signals, we thought we knew the rotation periods of those planets."

But when the Cassini probe arrived at Saturn 15 years later, its sensors detected its radio period had changed by about 1 percent. Karkoschka explained that because of its large mass, it was impossible for Saturn to incur that much change in its rotation over such a short time.

"Because the gas planets are so big, they have enough angular momentum to keep them spinning at pretty much the same rate for billions of years," he said. "So something strange was going on."

Even more puzzling was Cassini's later discovery that Saturn's northern and southern hemispheres appear to be rotating at different speeds.

"That's when we realized the magnetic field is not like clockwork but slipping," Karkoschka said. "The interior is rotating and drags the magnetic field along, but because of the solar wind or other, unknown influences, the magnetic field cannot keep up with respect to the planet's core and lags behind."

Instead of spacecraft powered by billions of dollars, Karkoschka took advantage of what one might call the scraps of space science: publicly available images of Neptune from the Hubble Space Telescope archive. With unwavering determination and unmatched patience, he then pored over hundreds of images, recording every detail and tracking distinctive features over long periods of time.

Other scientists before him had observed Neptune and analyzed images, but nobody had sleuthed through 500 of them.

"When I looked at the images, I found Neptune's rotation to be faster than what Voyager observed," Karkoschka said. "I think the accuracy of my data is about 1,000 times better than what we had based on the Voyager measurements -- a huge improvement in determining the exact rotational period of Neptune, which hasn't happened for any of the giant planets for the last three centuries."

Two features in Neptune's atmosphere, Karkoschka discovered, stand out in that they rotate about five times more steadily than even Saturn's hexagon, the most regularly rotating feature known on any of the gas giants.

Named the South Polar Feature and the South Polar Wave, the features are likely vortices swirling in the atmosphere, similar to Jupiter's famous Red Spot, which can last for a long time due to negligible friction. Karkoschka was able to track them over the course of more than 20 years.

An observer watching the massive planet turn from a fixed spot in space would see both features appear exactly every 15.9663 hours, with less than a few seconds of variation.

"The regularity suggests those features are connected to Neptune's interior in some way," Karkoschka said. "How they are connected is up to speculation."

One possible scenario involves convection driven by warmer and cooler areas within the planet's thick atmosphere, analogous to hot spots within the Earth's mantle, giant circular flows of molten material that stay in the same location over millions of years.

"I thought the extraordinary regularity of Neptune's rotation indicated by the two features was something really special," Karkoschka said.

"So I dug up the images of Neptune that Voyager took in 1989, which have better resolution than the Hubble images, to see whether I could find anything else in the vicinity of those two features. I discovered six more features that rotate with the same speed, but they were too faint to be visible with the Hubble Space Telescope, and visible to Voyager only for a few months, so we wouldn't know if the rotational period was accurate to the six digits. But they were really connected. So now we have eight features that are locked together on one planet, and that is really exciting."

In addition to getting a better grip on Neptune's rotational period, the study could lead to a better understanding of the giant gas planets in general.

"We know Neptune's total mass but we don't know how it is distributed," Karkoschka explained. "If the planet rotates faster than we thought, it means the mass has to be closer to the center than we thought. These results might change the models of the planets' interior and could have many other implications."

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Arizona**.

http://www.sciencedaily.com/releases/2011/06/110630091826.htm

Foxconn aims for a million robot workers by 2014

12:50 2 August 2011
Robots

Jacob Aron, technology reporter

On their way out? (Image: Thomas Lee/Bloomberg/Getty Images)

It's certainly one way of dealing with a bit of bad publicity. Foxconn, the Taiwanese manufacturer that assembles gadgets for the likes of Apple and Nintendo came under fire last year after a spate of high-profile suicides by its workers. Now it says it plans to replace much of its human workforce - with a million robots.

Foxconn is currently the largest private-sector employer in China with over one million employees. Last year 17 workers killed themselves - most by throwing themselves from factory buildings - while many more were stopped from doing so. The ensuing criticism and bad headlines worldwide forced the manufacturer to double its workers' salaries.

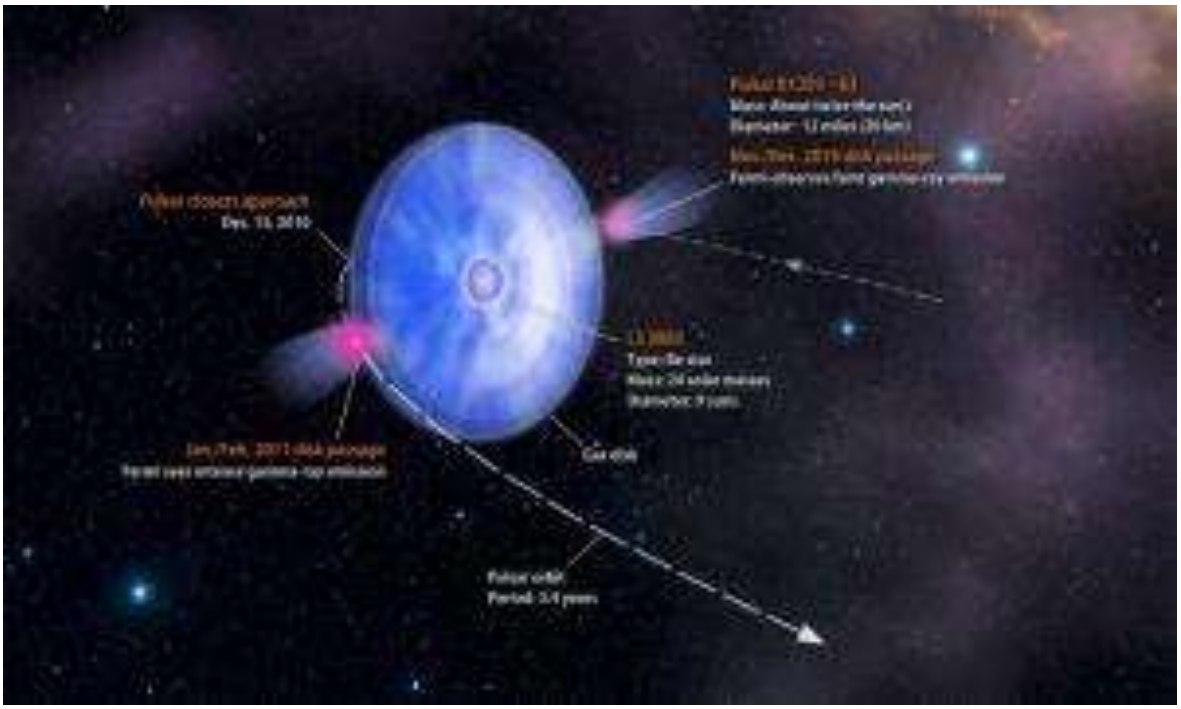
Now founder and chairman Terry Gou says he wants to cut rising labour costs and improve efficiency by replacing workers with robots that can perform tasks such as spraying, welding and assembling. He says Foxconn will boost its robotic workforce from 10,000 to 300,000 next year before reaching 1 million by 2014.

Forget visions of identical humanoid robots working side by side though, as the machines are unlikely to be any more than robotic arms. Statistics from the International Federation of Robotics (IFR) also suggest that Foxconn has set its sights incredibly high compared to the current state of industrial robotics.

The IFR says that there were around 1,020,000 industrial robots operational in 2009, and it predicts that total will reach just under 1,120,000 by the end of 2013. It also says that only 2,230,000 industrial robots have ever been built since they were first introduced at the end of the 1960s.

http://www.newscientist.com/blogs/onepercent/2011/08/foxconn-aims-for-a-million-rob.html

'Odd Couple' Binary Makes Dual Gamma-Ray Flares



This diagram, which illustrates the view from Earth, shows the binary's anatomy as well as key events in the pulsar's recent close approach. (Credit: NASA's Goddard Space Flight Center/Francis Reddy)

ScienceDaily (June 29, 2011) — In December 2010, a pair of mismatched stars in the southern constellation Crux whisked past each other at a distance closer than Venus orbits the sun. The system possesses a so-far unique blend of a hot and massive star with a compact fast-spinning pulsar. The pair's closest encounters occur every 3.4 years and each is marked by a sharp increase in gamma rays, the most extreme form of light.

The unique combination of stars, the long wait between close approaches, and periods of intense gamma-ray emission make this system irresistible to astrophysicists. Now, a team using NASA's Fermi Gamma-ray Space Telescope to observe the 2010 encounter reports that the system displayed fascinating and unanticipated activity.

"Even though we were waiting for this event, it still surprised us," said Aous Abdo, a Research Assistant Professor at George Mason University in Fairfax, Va., and a leader of the research team.

Few pairings in astronomy are as peculiar as high-mass binaries, where a hot blue-white star many times the sun's mass and temperature is joined by a compact companion no bigger than Earth -- and likely much smaller. Depending on the system, this companion may be a burned-out star known as a white dwarf, a city-sized remnant called a neutron star (also known as a pulsar) or, most exotically, a black hole.

Just four of these "odd couple" binaries were known to produce gamma rays, but in only one of them did astronomers know the nature of the compact object. That binary consists of a pulsar designated PSR B1259-63 and a 10th-magnitude Be-type star known as LS 2883. The pair lies 8,000 light-years away.

The pulsar is a fast-spinning neutron star with a strong magnetic field. This combination powers a lighthouse-like beam of energy, which astronomers can easily locate if the beam happens to sweep toward Earth. The

beam from PSR B1259-63 was discovered in 1989 by the Parkes radio telescope in Australia. The neutron star is about the size of Washington, D.C., weighs about twice the sun's mass, and spins almost 21 times a second.

The pulsar follows an eccentric and steeply inclined orbit around LS 2883, which weighs roughly 24 solar masses and spans about nine times its size. This hot blue star sits embedded in a disk of gas that flows out from its equatorial region.

At closest approach, the pulsar passes less than 63 million miles from its star -- so close that it skirts the gas disk around the star's middle. The pulsar punches through the disk on the inbound leg of its orbit. Then it swings around the star at closest approach and plunges through the disk again on the way out.

"During these disk passages, energetic particles emitted by the pulsar can interact with the disk, and this can lead to processes that accelerate particles and produce radiation at different energies," said study co-author Simon Johnston of the Australia Telescope National Facility in Epping, New South Wales. "The frustrating thing for astronomers is that the pulsar follows such an eccentric orbit that these events only happen every 3.4 years."

In anticipation of the Dec. 15, 2010, closest approach, astronomers around the world mounted a multiwavelength campaign to observe the system over a broad energy range, from radio wavelengths to the most energetic gamma rays detectable. The observatories included Fermi and NASA's Swift spacecraft; the European space telescopes XMM-Newton and INTEGRAL; the Japan-U.S. Suzaku satellite; the Australia Telescope Compact Array; optical and infrared telescopes in Chile and South Africa; and the High Energy Stereoscopic System (H.E.S.S.), a ground-based observatory in Namibia that can detect gamma rays with energies of trillions of electron volts, beyond Fermi's range. (For comparison, the energy of visible light is between two and three electron volts.)

"When you know you have a chance of observing this system only once every few years, you try to arrange for as much coverage as you can," said Abdo, the principal investigator of the NASA-funded international campaign. "Understanding this system, where we know the nature of the compact object, may help us understand the nature of the compact objects in other, similar systems."

Despite monitoring of the system with the EGRET telescope aboard NASA's Compton Gamma-Ray Observatory in the 1990s, gamma-ray emission in the billion-electron-volt (GeV) energy range had never been seen from the binary.

Late last year, as the pulsar headed toward its massive companion, the Large Area Telescope (LAT) aboard Fermi discovered faint gamma-ray emission.

"During the first disk passage, which lasted from mid-November to mid-December, the LAT recorded faint yet detectable emission from the binary. We assumed that the second passage would be similar, but in mid-January 2011, as the pulsar began its second passage through the disk, we started seeing surprising flares that were many times stronger than those we saw before," Abdo said.

Stranger still, the system's output at radio and X-ray energies showed nothing unusual as the gamma-ray flares raged.

"The most intense days of the flare were Jan. 20 and 21 and Feb. 2, 2011," said Abdo. "What really surprised us is that on any of these days, the source was more than 15 times brighter than it was during the entire month-and-a-half-long first passage."

The study will appear in the July 20 issue of The *Astrophysical Journal Letters* and is available online.

"One great advantage of the Fermi LAT observations is the continuous monitoring of the source, which gives us the most complete gamma-ray observations of this system," said Julie McEnery, the Fermi project scientist at NASA's Goddard Space Flight Center in Greenbelt, Md.

Astronomers are continuing to analyze their bounty of data and working to understand the surprising flares. And in May 2014, when the pulsar once again approaches its giant companion, they'll be watching.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **NASA/Goddard Space Flight Center**.

Journal Reference:

1. Abdo et al. **Discovery of High-energy Gamma-ray Emission from the Binary System PSR B1259–63/LS 2883 around Periastron with Fermi**. *The Astrophysical Journal*, 2011; 736 (1): L11 DOI: 10.1088/2041-8205/736/1/L11

http://www.sciencedaily.com/releases/2011/06/110629171226.htm

Subatomic Quantum Memory in Diamond Demonstrated

Greg Fuchs of University of California - Santa Barbara. (Credit: UCSB)

ScienceDaily (June 28, 2011) — Physicists working at the University of California, Santa Barbara and the University of Konstanz in Germany have developed a breakthrough in the use of diamond in quantum physics, marking an important step toward quantum computing. The results are reported in this week's online edition of *Nature Physics*.

The physicists were able to coax the fragile quantum information contained within a single electron in diamond to move into an adjacent single nitrogen nucleus, and then back again using on-chip wiring.

"This ability is potentially useful to create an atomic-scale memory element in a quantum computer based on diamond, since the subatomic nuclear states are more isolated from destructive interactions with the outside world," said David Awschalom, senior author. Awschalom is director of UCSB's Center for Spintronics & Quantum Computation, professor of physics, electrical and computer engineering, and the Peter J. Clarke director of the California NanoSystems Institute.

Awschalom said the discovery shows the high-fidelity operation of a quantum mechanical gate at the atomic level, enabling the transfer of full quantum information to and from one electron spin and a single nuclear spin at room temperature. The process is scalable, and opens the door to new solid-state quantum device development.

Scientists have recently shown that it is possible to synthesize thousands of these single electron states with beams of nitrogen atoms, intentionally creating defects to trap the single electrons. "What makes this demonstration particularly exciting is that a nitrogen atom is a part of the defect itself, meaning that these sub-atomic memory elements automatically scale with the number of logical bits in the quantum computer," said lead author Greg Fuchs, a postdoctoral fellow at UCSB.

Rather than using logical elements like transistors to manipulate digital states like "0" or "1," a quantum computer needs logical elements capable of manipulating quantum states that may be "0" and "1" at the same time. Even at ambient temperature, these defects in diamond can do exactly that, and have recently become a leading candidate to form a quantum version of a transistor.

However, there are still major challenges to building a diamond-based quantum computer. One of these is finding a method to store quantum information in a scalable way. Unlike a conventional computer, where the memory and the processor are in two different physical locations, in this case they are integrated together, bit-for-bit.

"We knew that the nitrogen nuclear spin would be a good choice for a scalable quantum memory -- it was already there," said Fuchs. "The hard part was to transfer the state quickly, before it is lost to decoherence."

Awschalom explained: "A key breakthrough was to use a unique property of quantum physics -- that two quantum objects can, under special conditions, become mixed to form a new composite object." By mixing the quantum spin state of the electrons in the defect with the spin state of the nitrogen nucleus for a brief time -- less than 100 billionths of a second -- information that was originally encoded in the electrons is passed to the nucleus.

"The result is an extremely fast transfer of the quantum information to the long-lived nuclear spin, which could further enhance our capabilities to correct for errors during a quantum computation," said co-author Guido Burkard, a theoretical physicist at the University of Konstanz, who developed a model to understand the storage process.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - Santa Barbara**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. G. D. Fuchs, G. Burkard, P. V. Klimov, D. D. Awschalom. **A quantum memory intrinsic to single nitrogen–vacancy centres in diamond**. *Nature Physics*, 2011; DOI: 10.1038/nphys2026

http://www.sciencedaily.com/releases/2011/06/110627151724.htm

Home-made drone to help phone and Wi-Fi hackers

- 12:34 05 August 2011 by **Jesse Emspak**

Magazine issue 2825

Spy in the sky, yours for $3800 (Image: Mike Tassey and Richard Perkins)

Invisible to radar, a drone flies over a city, while a hacker uses it to attack the cellphone network, spy on the ground and monitor Wi-Fi networks. But this is no stolen military vehicle. It is a home-made drone built for just a few thousand dollars using parts legally bought on the internet.

This is the future of network hacking, as envisioned by security consultants Mike Tassey and Richard Perkins. They have now built such a drone to prove how easy it is.

Using commercially available parts, they built a plane called WASP that can be a moving base station for cellphone networks, a flying camera and a Wi-Fi "packet sniffer" – all at the same time. Everything was bought legally and building it did not require much engineering know-how, they say.

The drone's frame was bought for less than $300 on the internet. A GSM radio turned it into a mobile version of a cellphone tower, a video camera monitored the ground, while internet connectivity came from a USB dongle that can be bought in any electronics shop. The total cost of their drone was about $3800, says Tassey. The pair presented their work at the Black Hat Conference in Las Vegas last week.

Flying fake

Using the drone to attack a cellphone network would be as easy as flying while broadcasting the same signal as an ordinary cell tower, the pair say. Most cellphones are designed to latch on to the strongest available signal. If the local 3G or 4G network has a weaker signal than the one broadcast by the drone then the handset will default to GSM and can be tricked into latching onto the drone's antenna, using it as a base station.

In tests, Tassey and Perkins showed that the drone could then listen in, record phone calls and transmit the data over the internet.

But it's not all bad news. The pair say that a drone could run search patterns for lost hikers at a fraction of the cost of using a helicopter, for example.

http://www.newscientist.com/article/dn20771-homemade-drone-to-help-phone-and-wifi-hackers.html

The Smell of Danger: Rats Instinctively Avoid Compound in Carnivore Urine

Researchers have discovered a single compound found in high concentrations in the urine of carnivores that triggers an instinctual avoidance response in mice and rats. (Credit: © Oleg Kozlov / Fotolia)

ScienceDaily (June 28, 2011) — The mechanics of instinctive behavior are mysterious. Even something as simple as the question of how a mouse can use its powerful sense of smell to detect and evade predators, including species it has never met before, has been almost totally unknown at the molecular level until now.

David Ferrero and Stephen Liberles, neuroscientists at Harvard Medical School, have discovered a single compound found in high concentrations in the urine of carnivores that triggers an instinctual avoidance response in mice and rats. This is the first time that scientists have identified a chemical tag that would let rodents sense carnivores in general from a safe distance. The authors write that understanding the molecular basis of predator odor recognition by rodents will provide crucial tools to study the neural circuitry associated with innate behavior.

Their findings were published online in the *Proceedings of the National Academy of Science* on June 20, 2011.

The search began in 2006, when Stephen Liberles, now Assistant Professor of Cell Biology at Harvard Medical School, was working as a post-doc in the lab of Linda Buck. Buck was part of the team that won the Nobel Prize for identifying the receptors that allow olfactory neurons to detect odors. While in her lab, Liberles identified a new type of olfactory receptor, the trace amine-associated receptors (TAARs).

Mice have about 1200 kinds of odor receptors, and 14 kinds of TAARs. In comparison, humans -- who rely more on vision than smell -- have about 350 odor receptors and five TAARs.

Liberles's initial findings indicated that several of the TAARs detect chemicals found in mouse urine, including a chemical with enriched production by males. He wondered, could TAARs (which appear to have originally evolved from neurotransmitter receptors that mediate behavior and emotion) play a role in the social behavior of rodents? What other kinds of naturally occurring odors might they be able to detect?

In Liberles's lab at Harvard Medical School, graduate student David Ferrero began a search for other natural compounds that were detected by the TAARs. Working with commercially available predator and prey urine (used by gardeners to keep pests out of their crops and by hunters to mask their own scent or as lures for prey), Ferrero discovered that one of the 14 TAARs, TAAR4, detected the odor of several carnivores.

It seemed they had found a kairomone, a chemical that works like a pheromone, except that it communicates between members of different species instead of members of the same species. Prior to this discovery, the only known rodent-carnivore kairomones were a volatile compound produced by foxes, but not in that of other predators, and two non-volatile compounds produced by cats and rats (which prey on mice). Volatile compounds aerosolize and can be smelled at great distances; non-volatile compounds need to be sniffed more directly, something that would not be helpful in avoiding a predator directly but rather their terrain.

"One of the things that's really new here is that this is a generalized predator kairomone that's volatile," said Ferrero.

For rodents, it's the smell of danger.

Ferrero identified the compound that activates TAAR4 as 2-phenylethylamine, a product of protein metabolism. He then obtained specimens from 38 species of mammals and found elevated levels of 2-phenylethylamineby 18 of 19 species of carnivores, but not by non-carnivores (including rabbits, deer, primates, and a giraffe).

"It's been known so long that predator odors are great rodent deterrents, but we've discovered one molecule that's a key part of this ecological relationship," Ferrero said.

In a series of behavior tests, rats and mice showed a clear, innate avoidance to the smell of 2-phenylethylamine. The behavioral studies were repeated using a carnivore samples that had been depleted of 2-phenylethylamine. Rats failed to show full avoidance of the depleted carnivore urine, indicating that 2-phenylethylamine is a key trigger for predator avoidance.

Lacking the gene for TAAR4, humans can't experience anything like what rodents do when they smell 2-phenylethylamine. To us, it has a mildly inoffensive odor. But trimethylamine, a related organic compound that activates TAAR5, a receptor found in humans, is deeply repugnant to people.

What happens between the receptors and the parts of the brain that trigger that avoidance behavior remains a mystery, one with direct medical relevance.

According to Liberles, "In humans, the parts of the brain that deal with likes and dislikes go awry in many diseases, like drug addiction, and predator odor responses have been used to model stress and anxiety disorders. Going from chemicals to receptors to neural circuits to behaviors is a Holy Grail of neuroscience."

"The neural circuits are like a black box, but here we have identified a chemical stimulant and a candidate receptor that trigger one behavior," Ferrero said. "We feel this is an important first step to understanding the neural circuitry of innate behavior."

This research was funded by the National Institute On Deafness And Other Communication Disorders.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Harvard Medical School**.

Journal Reference:

1. D. M. Ferrero, J. K. Lemon, D. Fluegge, S. L. Pashkovski, W. J. Korzan, S. R. Datta, M. Spehr, M. Fendt, S. D. Liberles. **Detection and avoidance of a carnivore odor by prey**. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1103317108

http://www.sciencedaily.com/releases/2011/06/110628163325.htm

Sex on the brain: What turns women on, mapped out

- 11:55 05 August 2011 by **Linda Geddes**

Man locates clitoris at last (Image: International Society for Sexual Medicine)

It's what women have been telling men for decades: stimulating the vagina is not the same as stimulating the clitoris. Now brain scan data has added weight to their argument.

The precise locations that correspond to the vagina, cervix and female nipples on the brain's sensory cortex have been mapped for the first time, proving that vaginal stimulation activates different brain regions to stimulation of the clitoris. The study also found a direct link between the nipples and the genitals, which may explain why some women can orgasm through nipple stimulation alone. The discoveries could ultimately help women who have suffered nerve damage in childbirth or disease.

The sensory cortex is a strip of brain tissue positioned roughly under where the band between a pair of headphones sits. Across it, neurons linked to different body parts exchange information about the sensory information feeding into them. This is often depicted as the "sensory homunculus", a distorted image of a man stretched across the brain, with his genitals lying next to his feet (click here). The size of the body's parts show how much of the brain is dedicated to processing the sensory information from each body part.

The diagram was first published in 1951 after experiments conducted during brain surgery performed while the patients were conscious: the surgeon electrically stimulated different regions of the patients' brains and the patients reported the parts of their bodies in which they felt sensation as a result. But all the subjects were men. Until recently, the position of female genitalia on the homunculus had only been guessed at.

This changed last year when a team led by Lars Michels at University Children's Hospital in Zurich, Switzerland, used functional magnetic resonance imaging to confirm that the position of the clitoris on the homunculus was in approximately the same position as the penis in men. Barry Komisaruk at Rutgers University in Newark, New Jersey, and his colleagues have now used the same method to map the position of the clitoris, vagina and cervix on the sensory cortex as women stimulated themselves.

There, there and there

"This is hard proof that there is a big difference between stimulating those different regions," says Stuart Brody of the University of the West of Scotland in Paisley, UK, one of the researchers in the study.

Some have argued that women who derive pleasure from vaginal stimulation do so because their clitoris is being indirectly stimulated, but the current findings contradict this. "They support the reports of women that they experience orgasm from various forms of stimulation," says Beverly Whipple, also of Rutgers University, who was not involved in the current study.

It's the nipples, stupid

Komisaruk also checked what happened when women's nipples were stimulated, and was surprised to find that in addition to the chest area of the cortex lighting up, the genital area was also activated. "When I tell my male neuroscientist colleagues about this, they say: 'Wow, that's an exception to the classical homunculus,'" he says. "But when I tell the women they say: 'Well, yeah?'" It may help explain why a lot of women claim that nipple stimulation is erotic, he adds.

The next step is to map what other areas of the brain light up in response to clitoral and vaginal stimulation. Komisaruk would also like to see what happens when the area that supposedly contains the G-spot is stimulated, as women in the current study just stimulated the front wall of the vagina generally.

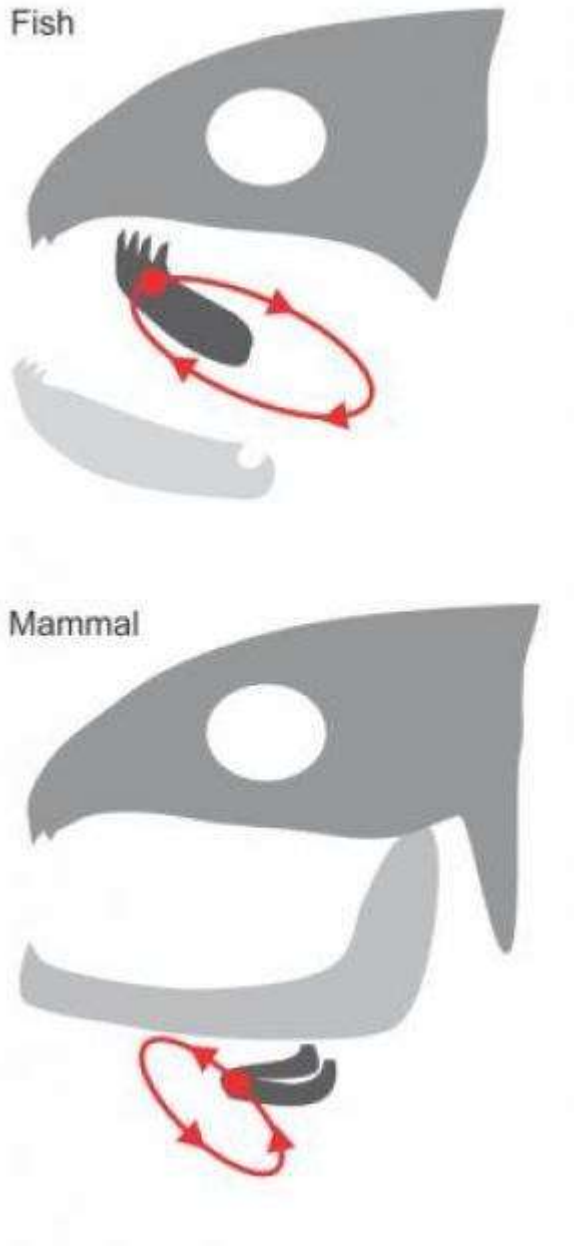
The findings could also help women who have suffered nerve damage in childbirth or because of diseases like diabetes. Michels has preliminary evidence that stimulating the clitoral nerve can improve symptoms of urinary incontinence, but says a proper understanding of how the nerve maps to the brain is needed to translate this into effective treatment.

Meanwhile, Komisaruk says that nipple stimulation could enhance genital sensation in women with nerve damage. "It could be a supplement for experiencing orgasm," he says.

Journal reference: *Journal of Sexual Medicine*, DOI: 10.1111/j.1743-6109.2011.02388.x

http://www.newscientist.com/article/dn20770-sex-on-the-brain-what-turns-women-on-mapped-out.html

Tongue Makes the Difference in How Fish and Mammals Chew



Chewing styles for different purposes. Fish use tongue muscles to thrust food backward, while mammals use tongue muscles to position food for grinding. (Credit: Image courtesy of Brown University)

ScienceDaily (July 3, 2011) — New research from Brown University shows that fish and mammals chew differently. Fish use tongue muscles to thrust food backward, while mammals use tongue muscles to position food for grinding. The evolutionary divergence is believed to have occurred with amphibians, though further research is needed to identify which species and when. Results are published in *Integrative and Comparative Biology*.

Evolution has made its marks -- large and small -- in innumerable patterns of life. New research from Brown University shows chewing has evolved too. Researchers looked at muscles that control the movement of the jaw and tongue in fish and in mammals. They learned that fish use tongue muscles primarily to funnel the food farther into the mouth for processing, as if the morsel were an object in an assembly line. Mammals use tongue muscles to position the food, so that jaw muscles can best use teeth to chew the food.

Chewing styles for different purposes

Fish use tongue muscles to thrust food backward, while mammals use tongue muscles to position food for grinding.The difference in chewing shows that animals have changed the way they chew and digest their food and that evolution must have played a role.

"It's pretty clear that all of these animals chew, but the involvement of the tongue in chewing differs," said Nicolai Konow, a postdoctoral researcher at Brown and the lead author on the study, published in the journal of *Integrative and Comparative Biology*. "And that brings up the question of what the muscles associated with the tongue and the jaw are doing."

In 2008 and last year, Konow and colleagues published papers showing the chewing technique of bowfin, pike, and fish with tiny teeth on their tongues such as salmon and osteoglossomorphs (fish with bony tongues). In some of these species, the researchers showed that chewing begins with the tongue positioned in the upper mouth. Then the fish fires the muscle, called the sternohyoid, downward, retracting the tongue inward, before moving it forward again, and upward, to its original position in the upper mouth. With the fish facing left, the chewing cycle looks like an ellipse tilted at an angle, with the tongue moving in a clockwise direction.

The finding was bolstered by earlier research by other scientists that showed the same chewing pattern in other fish, including bichir (a freshwater fish in Africa), gar, and, importantly, lungfish, which is believed to represent an early stage in the transition of some species from exclusively water- to land-dwelling.
In this paper, Konow and his team studied how the muscles of three mammals acted during chewing: alpacas, goats, and pigs. They outfitted each with electrodes planted in the jaw and tongue muscles to pinpoint the activity of each set of muscles during chewing. The analysis indicated that the animals' tongues thrust forward, and upward, as they began to chew and then fell back, or retracted, to their original position. With the animals facing left, the tongue traces an ellipse in a counter-clockwise direction for each cycle.
The distinction between fish and mammal chewing is likely there for a reason, Konow said. With fish, the tongue's function is to transport the food quickly into and through the mouth, where, in many species, an extra set (or sets) of jaws will grind the food. In addition, the tongue moves oxygenated water through the mouth to the gills, helping the fish to breathe.
"That's why you want to constantly have that inward movement with the tongue," Konow explained. Mammals, on the other hand, use their tongues to set the food in the right spot in the mouth to maximize chewing. But even among closely related species, there is a surprising difference: Herbivores, such as alpacas and goats, were less coordinated during chewing than omnivores, represented by the pigs. Cud-chewing animals were not as monotonously rhythmic in their chewing as many would believe.
"It is a puzzling finding," Konow said. "We think the herbivore needs the bolus (the soft mass of chewed food) to be in a precise place between each chew. So the tongue may be constantly moving around to make sure the bolus is in the right place between chews."
Next came the task of figuring out where, when and with what species the divergence in chewing emerged. Previous research by Anthony Herrel, a Belgian biologist now based at the Museum National D'Histoire Naturelle in Paris, showed that lizards fire their tongues forward and upward as they begin chewing, just like mammals. The thinking is that the transition likely occurred among amphibians. That makes sense, Konow said, and he plans to look next at amphibian chewing. "They're still locked to the water for reproduction," he said. "But you have some that become all terrestrial. And that's the next step on the evolutionary ladder."
Contributing authors include Herrel; Callum Ross from the University of Chicago; Susan Williams from Ohio University; Rebecca German from Johns Hopkins University; and Christopher Sanford and Chris Gintof from Hofstra University.
The U.S. National Institutes of Health and the U.S. National Science Foundation funded the research.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Brown University**.

Journal Reference:

1. N. Konow, A. Herrel, C. F. Ross, S. H. Williams, R. Z. German, C. P. J. Sanford, C. Gintof. **Evolution of Muscle Activity Patterns Driving Motions of the Jaw and Hyoid during Chewing in Gnathostomes**. *Integrative and Comparative Biology*, 2011; DOI: 10.1093/icb/icr040

http://www.sciencedaily.com/releases/2011/06/110627123136.htm

US internet providers hijacking users' search queries

- Updated 14:01 10 August 2011 by **Jim Giles**

Straight to spending (Image: Benjamin Rondel/First Light/Corbis)

Update: *Since the practice of redirecting users' searches was first exposed by* New Scientist *last week, we have learned that all the ISPs involved have now called a halt to the practice. They continue to intercept some queries – those from Bing and Yahoo – but are passing the searches on to the relevant search engine rather than redirecting them.*

Original story posted on 4 August 2011

Searches made by millions of internet users are being hijacked and redirected by some internet service providers in the US. Patents filed by Paxfire, the company involved in the hijacking, suggest that it may be part of a larger plan to allow ISPs to generate revenue by tracking the sites their customers visit. It may also be illegal.

Reese Richman, a New York law firm that specialises in consumer protection lawsuits, today filed a class action against one of the ISPs and Paxfire, which researchers believe provided the equipment used to hijack and redirect the searches. The suit, filed together with Milberg, another New York firm, alleges that the process violated numerous statutes, including wiretapping laws.

The hijacking seems to target searches for certain well-known brand names only. Users entering the term "apple" into their browser's search bar, for example, would normally get a page of results from their search engine of choice. The ISPs involved in the scheme intercept such requests before they reach a search engine, however. They pass the search to an online marketing company, which directs the user straight to Apple's online retail website.

More than 10 ISPs in the US, which together have several million subscribers, are redirecting queries in this way (see below for a complete list). None of the companies would comment on the redirection scheme, but evidence collected by Christian Kreibich and Nicholas Weaver at the International Computer Science Institute in Berkeley, California, who discovered the redirection and have been monitoring it for several months, suggest that the process generates revenue for the ISPs.

The Berkeley team has identified 165 search terms, from "apple" and "dell" to "safeway" and "bloomingdales", that are passed to marketing companies and then redirected to the appropriate retail website. The marketing companies include organisations like Commission Junction, a Santa Barbara, California, a firm that retailers pay to supply traffic to their websites.

Organisations that provide Commission Junction with traffic, which may include Paxfire and the ISPs the Berkeley team monitored, receive a cut of any purchase their users make. The cut is typically around 3 per cent. Commission Junction said that it was investigating the behaviour identified by the Berkeley researchers.

Buy, buy, buy

The process is highly contentious. A user who searched for "apple" would easily have found the company's store via a search engine, so Apple may be needlessly sharing revenue with Commission Junction and the ISPs. Search engines are also being deprived of traffic intended for them. The ISPs are understood to have stopped redirecting Google search traffic after the company complained to them earlier this year. All the ISPs identified by the Berkeley team redirect some Bing and Yahoo searches.

The redirection can also produce unwanted results. A user wanting to read an article in *The Wall Street Journal*, for instance, might search for "wsj"; the redirection system would take them to a page offering subscription deals for the paper. Searches for "kindle" are sent to Amazon, the company that makes the e-book reader of that name. A normal search for the term provides links to Wikipedia, reviews of the device and links to Kindles for sale on eBay.

"This interception and alteration of search traffic is not just your average privacy problem," says Peter Eckersley at the Electronic Frontier Foundation, a San Francisco-based internet advocacy group that helped the Berkeley team investigate the ISPs. "This is a deep violation of users' trust and expectations about how the internet is supposed to function."

It is not the first time that the desire of ISPs to monitor and monetise the traffic they carry has led to controversy. In 2008, service providers in the UK suffered a backlash after it emerged that they were working with Phorm, a company that developed techniques for tracking the interests and activities of internet users. Advertisers and publishers already track users' browsing, but ISPs are in a particularly powerful position because they can observe almost everything we do online. Many users complained about Phorm's data collection, prompting several ISPs to sever links with the company.

Paxfire connection

In this case, examination of the redirected traffic has led the Berkeley team to believe that the service is provided by Paxfire. The firm, based in Sterling, Virginia, has provided advertising services to ISPs since it was founded in 2003. As well as using Paxfire to redirect specific queries, the ISPs pass many, or perhaps all, searches on Google, Bing and Yahoo through Paxfire servers – a process that places Paxfire in a similar position to Phorm.

Paxfire executives did not reply to *New Scientist*'s multiple requests for comment, but the patents that Paxfire has been awarded, as well as others it has applied for, provide hints of its plans. In March, for example, company CEO Alan Sullivan applied for a patent for a system that would allow ISPs to create a "database of information about particular users" based on the searches and website visits observed by the service provider. The patent says that ISPs could use the information to display relevant advertising.

Paxfire is named in the lawsuit filed by Reese Richman and Milberg, alongside RCN, based in Herndon, Virginia, one of the ISPs identified by the Berkeley team. The suit, which was filed in the district court for the

southern district of New York, claims that the two companies violated privacy safeguards enshrined in the Wiretap Act, a 1968 law that regulates electronic communications.

Want to check whether your ISP is monitoring your searches? Try running this tool developed by the Berkeley researchers.

Shielding searches from prying eyes

Feel uneasy about the possibility of your internet search provider keeping tabs on your searches? A simple fix is at hand. Last year, Google launched a service that encrypts its search traffic, including the search term itself. To turn this encryption on, just use "https" instead of "http" at the beginning of the address that you have bookmarked for Google.

If you're a Firefox user and want to use encrypted communication on other sites, including Wikipedia, Twitter and Facebook, consider installing the HTTPS Everywhere extension developed by the Electronic Frontier Foundation. The extension automatically turns on encryption for around 1000 sites that offer it.

List of ISPs that are redirecting some search queries

Cavalier
Cincinnati Bell
Cogent
Frontier
Hughes
IBBS
Insight Broadband
Megapath
Paetec
RCN
Wide Open West
XO Communication

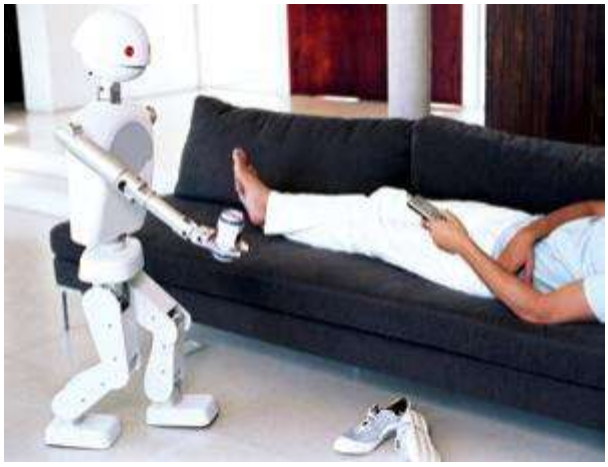
Charter and Iowa Telecom were observed to be redirecting search terms, but have since ceased doing so. Iowa Telecom stopped its redirection between July and September 2010, and Charter stopped in March 2011.

http://www.newscientist.com/article/dn20768-us-internet-providers-hijacking-users-search-queries.html

Crowdsourced online learning gives robots human skills

- 26 July 2011 by **Jim Giles**

Magazine issue 2822.



Can I get you anything else? (Image: Javier Pierini/Getty)

TWO robots named Rosie and James are making pancakes. It's a tough task that requires coordination, planning and a fine touch with a spatula. Midway through the process, Rosie slides the spatula under the half-cooked cake, lifts the pancake from the heat and carefully flips it over. The crowd breaks into cheers.

Rosie and James aren't quite the accomplished cooks they appear to be, however. As far as robots go, they are as flexible as they come, but they move haltingly, and their complex routine is the result of painstakingly crafted software instructions. Give Rosie and James a different recipe, for example, and their performance would suffer.

It's an age-old problem in robotics, but one that might just have a solution. Roboticists traditionally go to great lengths to coax automatons to perform highly specialised tasks, like cooking crêpes. But now they are turning to the crowd for help in giving robots more general skills. By allowing people to pilot real or simulated robots over the internet in trial experiments, they hope to recreate the fast and flexible behaviour that comes effortlessly to humans. "Crowdsourcing is a really viable path toward getting robots to do things that are useful for people," says Chad Jenkins, a robotics researcher at Brown University in Providence, Rhode Island.

The idea is inspired by successes in other areas of artificial intelligence. For example, online translation systems are trained on pairs of documents that have been translated by humans. By comparing translations with originals, the software learns how to translate words and phrases between different languages.

A similar approach could lead to better human-robot interactions, says Sonia Chernova at Worcester Polytechnic Institute in Massachusetts. To collect information on teamwork, social interaction and communication, she and colleagues created Mars Escape, an online game in which two people each control an avatar, one human and one robot, and work together to rescue objects from a doomed Martian research lab. After Mars Escape went online last year, Chernova logged the dialogue and action from over 550 sessions of the game.

The researchers first had to throw out unusual records, like dialogue between players who traded obscenities rather than working together. Then they looked for common patterns in the data, such as methods that players frequently used to retrieve objects, and phrases they exchanged when doing so. By having software watch how people tackled the game, the software learned how to work with a human. The technique could also find a use in the games industry (see "Build a better baddie").

The real test came last January, when Chernova and colleagues mocked up a real-life version of the Martian lab at the Museum of Science in Boston. Visitors were paired with a robot powered by software based on the Mars Escape data. The results were encouraging, Chernova and colleagues say in a paper to be presented next week at the International Symposium on Robot and Human Interactive Communication in Atlanta, Georgia. Sixteen out of 18 visitors worked with the robot to complete the game and most said the robot behaved rationally and contributed to their success.

Jenkins had similar success with a proof-of-principle experiment. Last year, he wired up a wheeled robot for online access and invited people to guide it through a simple maze. Over 270 people took up the challenge. He used the data they generated to build a navigation algorithm that allowed the robot to complete a maze it had not seen before.

His next experiment is more ambitious. His lab has a state-of-the-art PR2 - the same class of robot as James - that it plans to make available online. The robot will be placed in a kitchen and users will be invited to help it perform common tasks, like fetching objects from cupboards. The data they generate could help create better domestic robots, says Jenkins. The online interface will be demonstrated to researchers this August and should be available to the public by the end of the year.

The initial experiments have also flagged up some potential problems. Players in the real-life Mars Escape complained that the robot had poor communication skills, for example. This may be because the real robot often prompted different behaviour to its virtual version. For example, some visitors issued commands to move a specific distance. No players in the online game issued similar instructions, so the robot had no appropriate data to draw upon.

If such problems can be tackled, the technique has potential, says Jenkins. Many researchers focus on domestic tasks, but people in the outside world might prioritise other uses once they get control of robots. He draws an analogy with the early days of the internet: researchers built a data-sharing system and did not anticipate the emergence of Wikipedia and social networking. As for what those other uses are, Jenkins says we will have to wait: "If I had a good sense of other great applications, I would be doing them already."

Build a better baddie

In Jeff Orkin's vision of the future, gamers doing battle in zombie-filled shoot 'em ups will be helping to build richer virtual characters. Orkin worked in the game industry before moving to the Massachusetts Institute of Technology. His system crafts artificial characters by observing how humans play.

The system makes recordings of dialogue and action from games, which are annotated so the software knows what is happening at each point. Then virtual characters in other games can tap into the annotated data to simulate human-like behaviour. Slain by a sarcastic swordsman or glib goblin? Next time, you might have to blame Orkin.

http://www.newscientist.com/article/mg21128225.000-crowdsourced-online-learning-gives-robots-human-skills.html

New Theory On Origin of Birds: Enlarged Skeletal Muscles

Ostriches in South Africa's Kruger National Park. A developmental biologist is proposing a new theory of the origin of birds, which traditionally has been thought to be driven by the evolution of flight. The new theory credits the emergence of enlarged skeletal muscles as the basis for their upright two-leggedness, which led to the opportunity for other adaptive changes like flying or swimming. (Credit: © David Garry / Fotolia)

ScienceDaily (July 2, 2011) — A developmental biologist at New York Medical College is proposing a new theory of the origin of birds, which traditionally has been thought to be driven by the evolution of flight. Instead, Stuart A. Newman, Ph.D., credits the emergence of enlarged skeletal muscles as the basis for their upright two-leggedness, which led to the opportunity for other adaptive changes like flying or swimming. And it is all based on the loss of a gene that is critical to the ability of other warm-blooded animals to generate heat for survival.

Dr. Newman, a professor of cell biology and anatomy, studies the diversity of life and how it got that way. His research has always centered on bird development, though this current study, "Thermogenesis, muscle hyperplasia, and the origin of birds," also draws from paleontology, genetics, and the physiology of fat. Dr. Newman draws on earlier work from his laboratory that provided evidence for the loss, in the common dinosaur ancestors of birds and lizards, of the gene for uncoupling protein-1 (UCP1). The product of this gene is essential for the ability of "brown fat," tissue that protects newborns of mammals from hypothermia, to generate heat. In birds, heat generation is mainly a function of skeletal muscles.

"Unlike the scenario in which the evolution of flight is the driving force for the origin of birds, the muscle expansion theory does not require functionally operative intermediates in the transition to flight, swimming, or winglessness, nor does it require that all modern flightless birds, such as ostriches and penguins, had flying ancestors. It does suggest that the extinction of non-avian dinosaurs may have been related to a failure to evolve compensatory heat-generating mechanisms in face of the loss of UCP1," says the scientist

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **New York Medical College**, via EurekAlert!, a service of AAAS.

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Australia's overheated climate debate

- 09 August 2011 by **Clive Hamilton**

Magazine issue 2824.

Overshadowing the science (Image: Greg Wood/Getty)

Climate-change wrangling in Australia has descended into death threats and extreme insults. The science is being drowned out

THE battle over global warming, reaching fever pitch in Australia amid plans to introduce a carbon tax, is part of a long-running and bitter culture war between conservatives and liberals dating from the 1960s.

In the US, it is no accident that the Tea Party seamlessly incorporated climate-change denial into its suggestions of a liberal elite conspiracy and claims of populist rage. The same toxic brew is being drunk in Australia, a nation that has always hovered between European social democracy and US individualism.

There, climate scientists report death threats, figures on the right of the conservative opposition party mutter about excessive United Nations power, and protesters wave placards calling Prime Minister Julia Gillard "Bob Brown's Bitch" - a reference to the leader of the Australian Greens party, who holds the balance of power in the upper house of the nation's parliament.

The torrent of abuse has been led by Sydney's right-wing shock jocks, such as Alan Jones. He refers to Gillard as "Ju-Liar".

The ugliness on the air-waves has broken even commercial radio's bounds of decency, with Jones allowing one caller to complain bitterly that tax payers have to pay for Gillard's tampons.

Leader of the Conservative opposition, Tony Abbott, is vigorously stoking the fire with his trademark blend of alpha-male swagger and hyperbolic claims about the ruinous effects of the carbon tax. On paper, the opposition party has committed Australia to the same emission cuts as the government - a 5 per cent reduction on 2000 levels by 2020. Against the advice of economists and the Federal Treasury, Abbott insists the target can be reached more cheaply by "direct action", such as paying farmers to enhance carbon sequestration in soil.

His rejection of climate science - he once called it "crap" and is the only political leader to have agreed to meet leading denier Christopher Monckton - has emboldened climate sceptics everywhere. The carbon tax uproar has not been confined to the right-wing fringe but has spread to the majority. Polls show that the incumbent Labor party would be trounced were an election held now. Pundits are revising their view that Abbott is unelectable, because his testosterone-soaked presence is a turn-off to women voters.

All of which raises the most puzzling feature of Australian climate politics. For years voters have made it clear they want their government to do something. Even John Howard, a sceptic prime minister, was forced to go to the 2007 election promising to match the opposing Labor party by introducing an emissions trading system. His lack of action on climate change was one of the three factors that saw Labor's Kevin Rudd replace him as prime minister.

Rudd received a standing ovation at the UN climate conference in Bali, Indonesia, in 2007 when he announced that his government would ratify the Kyoto protocol, and Australians felt a rush of pride. But as Rudd got close to legislating for emissions trading, his poll ratings faltered. Nervous and under pressure from colleagues less committed to climate action, he abandoned his emissions trading policy only to see his public support collapse. He stood down, replaced by Gillard.

So to the riddle of Australian politics: voters want a strong leader, but one who will deliver only symbols of action on climate change. Australians want to feel good about themselves without making any sacrifices.

The source of the venom directed at Gillard seems to lie in this flaw in the modern Australian character. Confusing what Australians say they want with what they actually want, her plan to push through a carbon tax has turned her into a hate figure.

Behind it all has been perhaps the most potent force in the nation, the mining industry. Miners have always been powerful, but the China-driven minerals boom of the last few years has created a cadre of militant rich with an enormous sense of entitlement and a willingness to fight "government interference". A dispute in 2010, which was sparked by a proposed mining super-profits tax, was a defining moment.

It was enough to unite corporate giants such as Rio Tinto and BHP Billiton with the new crop of belligerent billionaires whose iron ore and coal companies have been turned into behemoths by China's industrialisation. They set up a A$100 million fighting fund that spooked the government.

In a bizarre spectacle, Western Australian mining moguls Gina Rinehart (who has assets of A$4.75 billion) and Andrew Forrest (worth A$4.24 billion) gathered employees in an anti-tax rally in Perth in which they pumped the air with their fists and demanded justice. Eventually concessions on the tax were won.

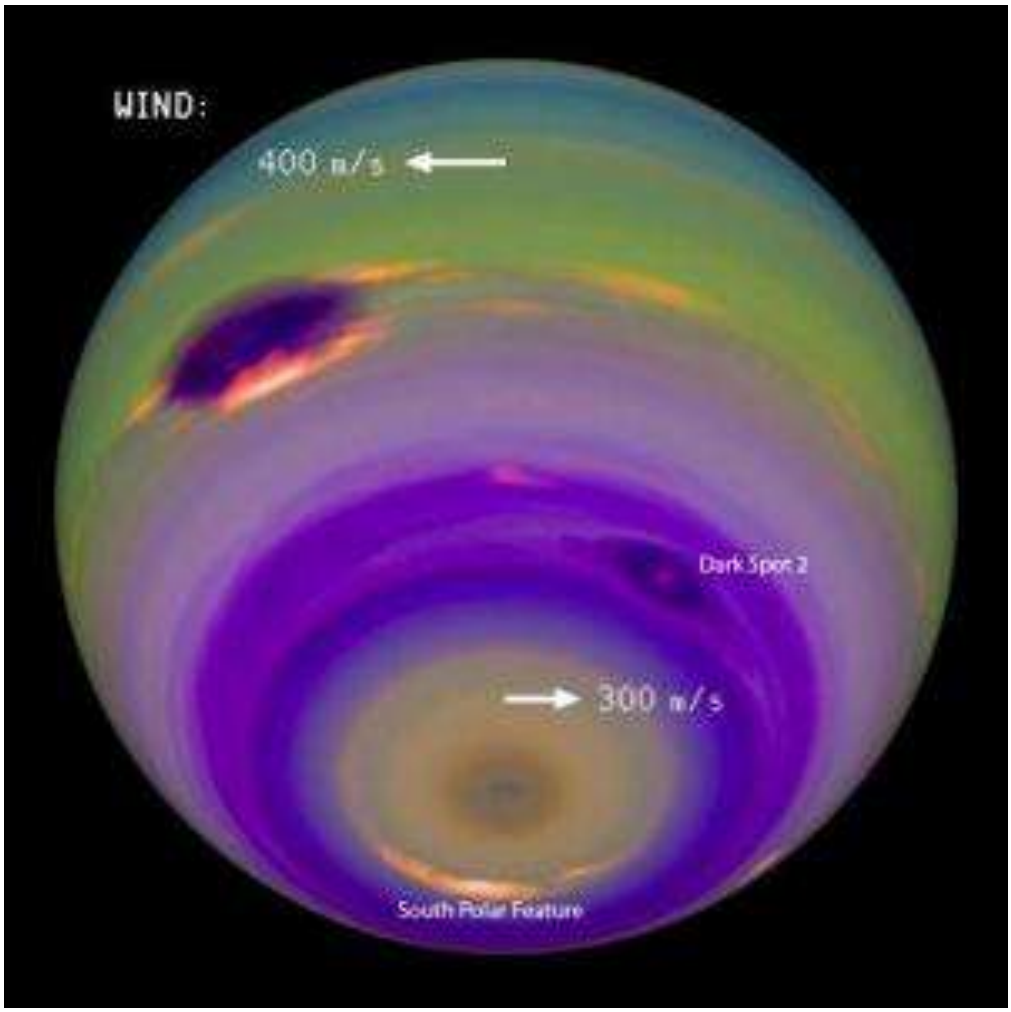
Back to current events and Monckton's lecture tour. It got off to a shaky start when images emerged from the US of him describing Ross Garnaut, the economist whose study underpins the carbon tax, as a fascist, quoting words from Garnaut's report under a giant swastika.

Those who turn up to Monckton's rallies wave placards reading "Ditch the Witch" and "Ju-Liar". Anti-tax populism now verges on extremist violence. At a public lecture on 12 July in Melbourne by eminent German climate scientist Hans Schellnhuber, a protester from a far-right "citizens group" brandished a noose. The urbane Schellnhuber was shaken and left the country with this warning to fellow climate scientists: "Some day some madman will draw a pistol and shoot you. It will happen - to me or somebody else. I'm pretty sure about that."

Clive Hamilton *is the author of Requiem for a Species: Why we resist the truth about climate change (Earthscan, 2010) and professor of public ethics at Australia's Centre for Applied Philosophy and Public Ethics*

http://www.newscientist.com/article/mg21128240.200-australias-overheated-climate-debate.html

Clocking Neptune's Spin by Tracking Atmospheric Features



ÿÿIn this image, the colors and contrasts were modified to emphasize the planet's atmospheric features. The winds in Neptune's atmosphere can reach the speed of sound or more. Neptune's Great Dark Spot stands out as the most prominent feature on the left. Several features, including the fainter Dark Spot 2 and the South Polar Feature, are locked to the planet's rotation, which allowed Karkoschka to precisely determine how long a day lasts on Neptune. (Credit: Erich Karkoschka)

ScienceDaily (July 1, 2011) — A day on Neptune lasts precisely 15 hours, 57 minutes and 59 seconds, according to the first accurate measurement of its rotational period made by University of Arizona planetary scientist Erich Karkoschka.

His result is one of the largest improvements in determining the rotational period of a gas planet in almost 350 years since Italian astronomer Giovanni Cassini made the first observations of Jupiter's Red Spot.

"The rotational period of a planet is one of its fundamental properties," said Karkoschka, a senior staff scientist at the UA's Lunar and Planetary Laboratory. "Neptune has two features observable with the Hubble Space Telescope that seem to track the interior rotation of the planet. Nothing similar has been seen before on any of the four giant planets."

The discovery is published in *Icarus*, the official scientific publication of the Division for Planetary Sciences of the American Astronomical Society.

Unlike the rocky planets -- Mercury, Venus, Earth and Mars -- which behave like solid balls spinning in a rather straightforward manner, the giant gas planets -- Jupiter, Saturn, Uranus and Neptune -- rotate more like giant blobs of liquid. Since they are believed to consist of mainly ice and gas around a relatively small solid

core, their rotation involves a lot of sloshing, swirling and roiling, which has made it difficult for astronomers to get an accurate grip on exactly how fast they spin around.
"If you looked at Earth from space, you'd see mountains and other features on the ground rotating with great regularity, but if you looked at the clouds, they wouldn't because the winds change all the time," Karkoschka explained. "If you look at the giant planets, you don't see a surface, just a thick cloudy atmosphere."
"On Neptune, all you see is moving clouds and features in the planet's atmosphere. Some move faster, some move slower, some accelerate, but you really don't know what the rotational period is, if there even is some solid inner core that is rotating."
In the 1950s, when astronomers built the first radio telescopes, they discovered that Jupiter sends out pulsating radio beams, like a lighthouse in space. Those signals originate from a magnetic field generated by the rotation of the planet's inner core.
No clues about the rotation of the other gas giants, however, were available because any radio signals they may emit are being swept out into space by the solar wind and never reach Earth.
"The only way to measure radio waves is to send spacecraft to those planets," Karkoschka said. "When Voyager 1 and 2 flew past Saturn, they found radio signals and clocked them at exactly 10.66 hours, and they found radio signals for Uranus and Neptune as well. So based on those radio signals, we thought we knew the rotation periods of those planets."
But when the Cassini probe arrived at Saturn 15 years later, its sensors detected its radio period had changed by about 1 percent. Karkoschka explained that because of its large mass, it was impossible for Saturn to incur that much change in its rotation over such a short time.
"Because the gas planets are so big, they have enough angular momentum to keep them spinning at pretty much the same rate for billions of years," he said. "So something strange was going on."
Even more puzzling was Cassini's later discovery that Saturn's northern and southern hemispheres appear to be rotating at different speeds.
"That's when we realized the magnetic field is not like clockwork but slipping," Karkoschka said. "The interior is rotating and drags the magnetic field along, but because of the solar wind or other, unknown influences, the magnetic field cannot keep up with respect to the planet's core and lags behind."
Instead of spacecraft powered by billions of dollars, Karkoschka took advantage of what one might call the scraps of space science: publicly available images of Neptune from the Hubble Space Telescope archive. With unwavering determination and unmatched patience, he then pored over hundreds of images, recording every detail and tracking distinctive features over long periods of time.
Other scientists before him had observed Neptune and analyzed images, but nobody had sleuthed through 500 of them.
"When I looked at the images, I found Neptune's rotation to be faster than what Voyager observed," Karkoschka said. "I think the accuracy of my data is about 1,000 times better than what we had based on the Voyager measurements -- a huge improvement in determining the exact rotational period of Neptune, which hasn't happened for any of the giant planets for the last three centuries."
Two features in Neptune's atmosphere, Karkoschka discovered, stand out in that they rotate about five times more steadily than even Saturn's hexagon, the most regularly rotating feature known on any of the gas giants. Named the South Polar Feature and the South Polar Wave, the features are likely vortices swirling in the atmosphere, similar to Jupiter's famous Red Spot, which can last for a long time due to negligible friction. Karkoschka was able to track them over the course of more than 20 years.
An observer watching the massive planet turn from a fixed spot in space would see both features appear exactly every 15.9663 hours, with less than a few seconds of variation.
"The regularity suggests those features are connected to Neptune's interior in some way," Karkoschka said. "How they are connected is up to speculation."
One possible scenario involves convection driven by warmer and cooler areas within the planet's thick atmosphere, analogous to hot spots within the Earth's mantle, giant circular flows of molten material that stay in the same location over millions of years.
"I thought the extraordinary regularity of Neptune's rotation indicated by the two features was something really special," Karkoschka said.
"So I dug up the images of Neptune that Voyager took in 1989, which have better resolution than the Hubble images, to see whether I could find anything else in the vicinity of those two features. I discovered six more

features that rotate with the same speed, but they were too faint to be visible with the Hubble Space Telescope, and visible to Voyager only for a few months, so we wouldn't know if the rotational period was accurate to the six digits. But they were really connected. So now we have eight features that are locked together on one planet, and that is really exciting."
In addition to getting a better grip on Neptune's rotational period, the study could lead to a better understanding of the giant gas planets in general.
"We know Neptune's total mass but we don't know how it is distributed," Karkoschka explained. "If the planet rotates faster than we thought, it means the mass has to be closer to the center than we thought. These results might change the models of the planets' interior and could have many other implications."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Arizona**. The original article was written by Daniel Stolte, University Communications.

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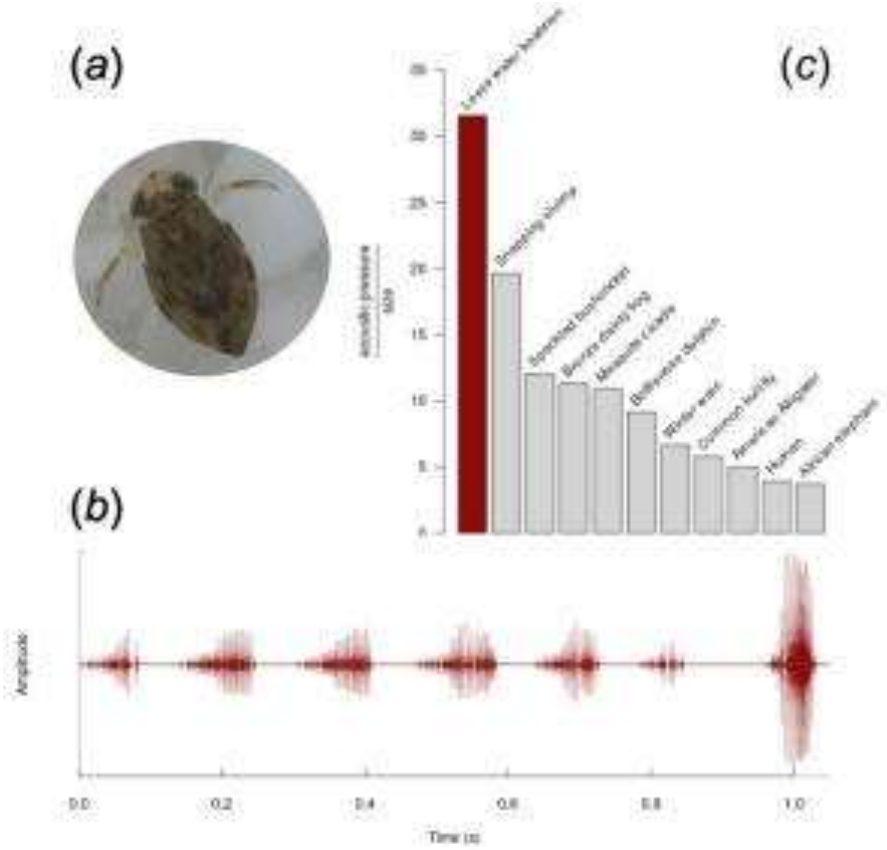
Loudest Animal Is Recorded for the First Time



The water boatman (Micronecta scholtzi), shown at the top left, is only 2mm long but is the loudest animal ever to be recorded, relative to its body size, outperforming all marine and terrestrial species. (Credit: Images courtesy of Dr. Jérôme Sueur, Muséum national d'Histoire naturelle, Paris)

ScienceDaily (July 1, 2011) — Scientists have shown for the first time that the loudest animal on earth, relative to its body size, is the tiny water boatman, *Micronecta scholtzi*. At 99.2 decibels, this represents the equivalent of listening to an orchestra play loudly while sitting in the front row.

The frequency of the sound (around 10 kHz) is within human hearing range and Dr. James Windmill of the University of Strathclyde, explains one clue as to how loud the animals are: "Remarkably, even though 99% of sound is lost when transferring from water to air, the song is so loud that a person walking along the bank can actually hear these tiny creatures singing from the bottom of the river."

The song, used by males to attract mates, is produced by rubbing two body parts together, in a process called stridulation. In water boatmen the area used for stridulation is only about 50 micrometres across, roughly the width of a human hair. "We really don't know how they make such a loud sound using such a small area," says Dr. Windmill.

The researchers, who are presenting their work at the Society for Experimental Biology Annual Conference in Glasgow, are now keen to bring together aspects of biology and engineering to clarify how and why such a small animal makes such a loud noise, and to explore the practical applications. Dr. Windmill explains: "Biologically this work could be helpful in conservation as recordings of insect sounds could be used to

monitor biodiversity. From the engineering side it could be used to inform our work in acoustics, such as in sonar systems."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Society for Experimental Biology**, via EurekAlert!, a service of AAAS.

Journal Reference:

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http://www.sciencedaily.com/releases/2011/07/110701121519.htm

Black gold holds a charge for green cars

- 08 August 2011 by **Ferris Jabr**
- Magazine issue 2824.

It packs a lot more juice (Image: Dominick Reuter)

THE tiny glass bottle in my hand is filled with what looks like crude oil, but it's actually oil's nemesis. If it works, this black sludge will transform the rechargeable battery, doubling the range of electric cars and making petroleum obsolete.

Today's electric cars are handicapped by batteries that are heavy, expensive and a waste of space. Two-thirds of the volume of the battery in Nissan's Leaf electric car, for example, consists of materials that provide structural support but generate no power. And those materials cost more than the electrically active components.

One way to vastly improve rechargeable batteries is to put more of that deadweight to work. That's the purpose of the secret sauce in the bottle, nicknamed "Cambridge crude" by Yet-Ming Chiang and his colleagues at the Massachusetts Institute of Technology, who developed it.

In a standard battery, ions shuttle from one solid electrode to the other through a liquid or powder electrolyte. This in turn forces electrons to flow in an external wire linking the electrodes, creating a current. In Chiang's battery, the electrodes take the form of tiny particles of a lithium compound mixed with liquid electrolyte to make a slurry. The battery uses two streams of slurry, one positively charged and the other negatively charged. Both are pumped across aluminium and copper current collectors with a permeable membrane in between. As they flow the streams exchange lithium ions across the membrane, causing a current to flow externally. To recharge the battery, you apply a voltage to push the ions back across the membrane.

The MIT creation is a type of flow battery, which normally has a liquid electrolyte that moves past stationary electrodes. Chiang reckons that the power per unit volume delivered by his lithium "semi-solid" flow battery will be 10 times that of conventional designs (*Advanced Energy Materials*, DOI: 10.1002/aenm.201100152).

"This is probably the most exciting development in electrical energy storage in the past couple of years," says Yury Gogotsi of Drexel Nanotechnology Institute in Philadelphia, Pennsylvania. "Chiang offers a unique hybrid between a flow battery and a lithium-ion battery."

Drivers could have three ways of recharging the semi-solid flow battery. They could pump out spent slurry and pump in fresh; head to a recharge station where tanks of spent slurry would be replaced with fresh ones; or recharge the slurries with an electric current. In the first two cases regaining full power should only take a matter of minutes.

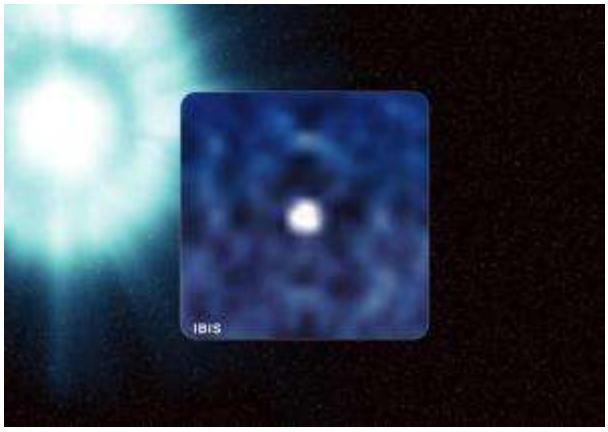
Rechargeable batteries are the heaviest and most expensive components of electric cars by a large margin. Chiang estimates that the cost of manufacturing his team's battery will be $250 per kilowatt-hour of generating capacity. So if one were built to replace the 24-kWh battery in the Nissan Leaf, it would cost $6000. That is about one-third the cost of existing batteries, and just low enough to compete with gasoline. Chiang also calculates that Cambridge crude would let a car travel at least 300 kilometres on a single charge, double what is possible with today's batteries.

"This is an especially beautiful technology," says Dan Steingart of the City University of New York Energy Institute, because you can recharge the spent slurry. But he adds that even if the team manages to create a prototype car battery within five years, building the recharge stations to support it would take much longer.

Last year Chiang, his colleague Craig Carter and entrepreneur Throop Wilder founded a company called 24M Technologies to develop the battery. They have raised $16 million in funding so far, and plan to have a compact prototype ready in 2013.

http://www.newscientist.com/article/mg21128246.500-black-gold-holds-a-charge-for-green-cars.html

Quantum 'Graininess' of Space at Smaller Scales? Gamma-Ray Observatory Challenges Physics Beyond Einstein



Gamma-ray burst captured by Integral's IBIS instrument. (Credit: ESA/SPI Team/ECF)

ScienceDaily (July 1, 2011) — The European Space Agency's Integral gamma-ray observatory has provided results that will dramatically affect the search for physics beyond Einstein. It has shown that any underlying quantum 'graininess' of space must be at much smaller scales than previously predicted.

Einstein's General Theory of Relativity describes the properties of gravity and assumes that space is a smooth, continuous fabric. Yet quantum theory suggests that space should be grainy at the smallest scales, like sand on a beach.

One of the great concerns of modern physics is to marry these two concepts into a single theory of quantum gravity.

Now, Integral has placed stringent new limits on the size of these quantum 'grains' in space, showing them to be much smaller than some quantum gravity ideas would suggest.

According to calculations, the tiny grains would affect the way that gamma rays travel through space. The grains should 'twist' the light rays, changing the direction in which they oscillate, a property called polarisation.

High-energy gamma rays should be twisted more than the lower energy ones, and the difference in the polarisation can be used to estimate the size of the grains.

Philippe Laurent of CEA Saclay and his collaborators used data from Integral's IBIS instrument to search for the difference in polarisation between high- and low-energy gamma rays emitted during one of the most powerful gamma-ray bursts (GRBs) ever seen.

GRBs come from some of the most energetic explosions known in the Universe. Most are thought to occur when very massive stars collapse into neutron stars or black holes during a supernova, leading to a huge pulse of gamma rays lasting just seconds or minutes, but briefly outshining entire galaxies.

GRB 041219A took place on 19 December 2004 and was immediately recognised as being in the top 1% of GRBs for brightness. It was so bright that Integral was able to measure the polarisation of its gamma rays accurately.

Dr Laurent and colleagues searched for differences in the polarisation at different energies, but found none to the accuracy limits of the data.

Some theories suggest that the quantum nature of space should manifest itself at the 'Planck scale': the minuscule 10^{-35} of a metre, where a millimetre is 10^{-3} m.

However, Integral's observations are about 10 000 times more accurate than any previous and show that any quantum graininess must be at a level of 10^{-48} m or smaller.

"This is a very important result in fundamental physics and will rule out some string theories and quantum loop gravity theories," says Dr Laurent.

Integral made a similar observation in 2006, when it detected polarised emission from the Crab Nebula, the remnant of a supernova explosion just 6500 light years from Earth in our own galaxy.

This new observation is much more stringent, however, because GRB 041219A was at a distance estimated to be at least 300 million light years.

In principle, the tiny twisting effect due to the quantum grains should have accumulated over the very large distance into a detectable signal. Because nothing was seen, the grains must be even smaller than previously suspected.
"Fundamental physics is a less obvious application for the gamma-ray observatory, Integral," notes Christoph Winkler, ESA's Integral Project Scientist. "Nevertheless, it has allowed us to take a big step forward in investigating the nature of space itself."
Now it's over to the theoreticians, who must re-examine their theories in the light of this new result.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **European Space Agency (ESA)**.

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http://www.sciencedaily.com/releases/2011/06/110630111540.htm

Polymer sandwich harvests electricity from waste heat

- 21 July 2011 by **Ferris Jabr**

Magazine issue 2821.

So much going to waste (Image: J.Baylor Roberts/NGS)

IN 314 BC the Greek philosopher Theophrastus noticed something unusual: when he heated a black crystalline rock called tourmaline, it would suddenly attract ash and bits of straw. He had observed what we now call pyroelectricity - the ability of certain crystals to produce a voltage briefly when heated or cooled. Now the same phenomenon is being used to convert waste heat into electricity.

Nearly 55 per cent of all the energy generated in the US in 2009 was lost as waste heat, according to research by the Lawrence Livermore National Laboratory in California. There have been many attempts at using this waste heat to generate electricity, so far with only limited success.

Pyroelectricity could be the key, say Scott Hunter and colleagues at Oak Ridge National Laboratory in Tennessee. They have built an energy harvester that sandwiches a layer of pyroelectric polymer between two electrodes made from different metals. Just a few millimetres long, the device is deployed by wedging it between a hot surface and a cold surface - between a computer chip and a fan inside a laptop, for example. Crucially, the device is anchored to the hot surface alone and so acts as a cantilever - a beam supported at one end.

As the device warms, the polymer expands more than the electrode close to the cold surface, and the whole device bends like the bimetallic strip in a thermostat. It droops toward the cold surface, where it cools and then springs back toward the hot surface, warming up again. Soon the cantilever is thrumming between the hot and cold surfaces like the hammer of a wind-up alarm clock. Each time it is heated, the polymer generates a small amount of electricity which is stored in a capacitor (*Proceedings of SPIE*, DOI: 10.1117/12.882125).

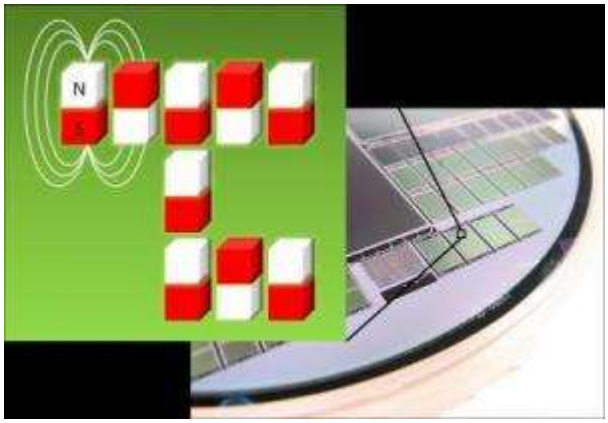
Previous attempts at using pyroelectric materials to recycle waste heat have only managed to turn 2 per cent of the heat into electricity. Hunter believes his device could achieve an efficiency of between 10 and 30 per cent.

Hunter says the device can also convert heat in exhaust gases into electricity. It might even be used to capture the energy that solar cells lose as heat, he says. Energy generation aside, he adds that the devices could soak up enough heat to play a significant role in cooling laptops and data centres.

Laurent Pilon of the University of California, Los Angeles, who also studies pyroelectric energy harvesting, says he likes the compactness of the device and its relative simplicity, but has some doubts about the potential efficiency. "I think some of their expectations are a little exaggerated," he says. "They are relying on conduction to heat the device, which is a slow process." He and other groups have used fluids to heat or chill a pyroelectric material. This is much quicker, though the need to pump the fluid around does consume some of the energy generated.

http://www.newscientist.com/article/mg21128215.900-polymer-sandwich-harvests-electricity-from-waste-heat.html

Ultimate Energy Efficiency: Magnetic Microprocessors Could Use Million Times Less Energy Than Today's Silicon Chips



Nanomagnetic computers use tiny bar magnets to store and process information. The interactions between the polarized, north-south magnetic fields of closely spaced magnets allow logic operations like those in conventional transistors. (Credit: Jeffrey Bokor lab, UC Berkeley)

ScienceDaily (July 1, 2011) — Future computers may rely on magnetic microprocessors that consume the least amount of energy allowed by the laws of physics, according to an analysis by University of California, Berkeley, electrical engineers.

Today's silicon-based microprocessor chips rely on electric currents, or moving electrons, that generate a lot of waste heat. But microprocessors employing nanometer-sized bar magnets -- like tiny refrigerator magnets -- for memory, logic and switching operations theoretically would require no moving electrons.

Such chips would dissipate only 18 millielectron volts of energy per operation at room temperature, the minimum allowed by the second law of thermodynamics and called the Landauer limit. That's 1 million times less energy per operation than consumed by today's computers.

"Today, computers run on electricity; by moving electrons around a circuit, you can process information," said Brian Lambson, a UC Berkeley graduate student in the Department of Electrical Engineering and Computer Sciences. "A magnetic computer, on the other hand, doesn't involve any moving electrons. You store and process information using magnets, and if you make these magnets really small, you can basically pack them very close together so that they interact with one another. This is how we are able to do computations, have memory and conduct all the functions of a computer."

Lambson is working with Jeffrey Bokor, UC Berkeley professor of electrical engineering and computer sciences, to develop magnetic computers.

"In principle, one could, I think, build real circuits that would operate right at the Landauer limit," said Bokor, who is a codirector of the Center for Energy Efficient Electronics Science (E3S), a Science and Technology Center founded last year with a $25 million grant from the National Science Foundation. "Even if we could get within one order of magnitude, a factor of 10, of the Landauer limit, it would represent a huge reduction in energy consumption for electronics. It would be absolutely revolutionary."

One of the center's goals is to build computers that operate at the Landauer limit.

Lambson, Bokor and UC Berkeley graduate student David Carlton published a paper about their analysis online in the journal *Physical Review Letters*.

Fifty years ago, Rolf Landauer used newly developed information theory to calculate the minimum energy a logical operation, such as an AND or OR operation, would dissipate given the limitation imposed by the second law of thermodynamics. (In a standard logic gate with two inputs and one output, an AND operation produces an output when it has two positive inputs, while an OR operation produces an output when one or both inputs are positive.) That law states that an irreversible process -- a logical operation or the erasure of a bit of information -- dissipates energy that cannot be recovered. In other words, the entropy of any closed system cannot decrease.

In today's transistors and microprocessors, this limit is far below other energy losses that generate heat, primarily through the electrical resistance of moving electrons. However, researchers such as Bokor are trying

to develop computers that don't rely on moving electrons, and thus could approach the Landauer limit. Lambson decided to theoretically and experimentally test the limiting energy efficiency of a simple magnetic logic circuit and magnetic memory.

The nanomagnets that Bokor, Lambson and his lab use to build magnetic memory and logic devices are about 100 nanometers wide and about 200 nanometers long. Because they have the same north-south polarity as a bar magnet, the up-or-down orientation of the pole can be used to represent the 0 and 1 of binary computer memory. In addition, when multiple nanomagnets are brought together, their north and south poles interact via dipole-dipole forces to exhibit transistor behavior, allowing simple logic operations.

"The magnets themselves are the built-in memory," Lambson said. "The real challenge is getting the wires and transistors working."

Lambson showed through calculations and computer simulations that a simple memory operation -- erasing a magnetic bit, an operation often called "restore to one" -- can be conducted with an energy dissipation very close, if not identical to, the Landauer limit.

He subsequently analyzed a simple magnetic logical operation. The first successful demonstration of a logical operation using magnetic nanoparticles was achieved by researchers at the University of Notre Dame in 2006. In that case, they built a three-input majority logic gate using 16 coupled nanomagnets. Lambson calculated that a computation with such a circuit would also dissipate energy at the Landauer limit.

Because the Landauer limit is proportional to temperature, circuits cooled to low temperatures would be even more efficient.

At the moment, electrical currents are used to generate a magnetic field to erase or flip the polarity of nanomagnets, which dissipates a lot of energy. Ideally, new materials will make electrical currents unnecessary, except perhaps for relaying information from one chip to another.

"Then you can start thinking about operating these circuits at the upper efficiency limits," Lambson said. "We are working now with collaborators to figure out a way to put that energy in without using a magnetic field, which is very hard to do efficiently," Bokor said. "A multiferroic material, for example, may be able to control magnetism directly with a voltage rather than an external magnetic field."

Other obstacles remain as well. For example, as researchers push the power consumption down, devices become more susceptible to random fluctuations from thermal effects, stray electromagnetic fields and other kinds of noise.

"The magnetic technology we are working on looks very interesting for ultra low power uses," Bokor said. "We are trying to figure out how to make it more competitive in speed, performance and reliability. We need to guarantee that it gets the right answer every single time with a very, very, very high degree of reliability."

The work was supported by NSF and the Defense Advanced Research Projects Agency.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - Berkeley**. The original article was written by Robert Sanders, Media Relations.

Journal Reference:

1. Brian Lambson, David Carlton, Jeffrey Bokor. **Exploring the Thermodynamic Limits of Computation in Integrated Systems: Magnetic Memory, Nanomagnetic Logic, and the Landauer Limit**. *Physical Review Letters*, 2011; 107: 010604 DOI: 10.1103/PhysRevLett.107.010604

http://www.sciencedaily.com/releases/2011/07/110701101737.htm

Fluorescent fish glows to show feminising chemicals up

- 10 June 2011
- Magazine issue 2816.

Oestrogen-infused waters (Image: Vitargent Biotechnology LTD)

FOR people worried about the feminising effect of oestrogen-like chemicals in the water there is now a modern-day equivalent of the canary in the coal mine: a genetically modified fish in a bowl.

Male fish exposed to oestrogen have delayed sperm development and grow smaller testes. Some industrial chemicals, such as bisphenol A, mimic oestrogen, but little is known about how the effects of different oestrogen-like chemicals add up in water.

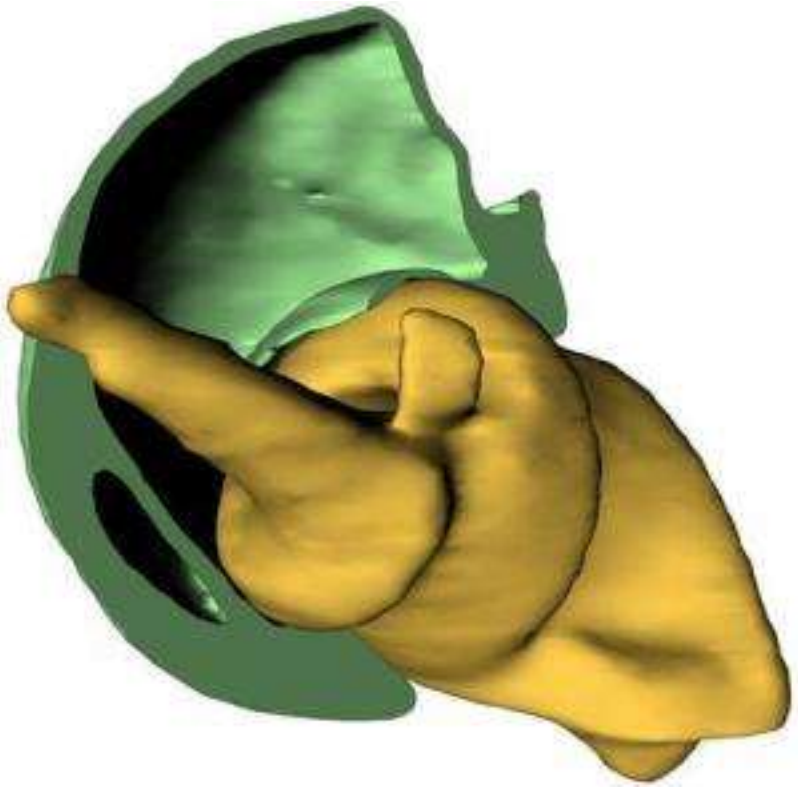
To find out, Xueping Chen and colleagues at Vitargent, a biotechnology company in Hong Kong, have created a genetically engineered fish that glows green when it is exposed to oestrogen-like chemicals. Chen's team took the green fluorescent protein gene from jellyfish and spliced it into the genome of the medaka fish, *Oryzias melastigma*, next to a gene that detects oestrogen. Chemicals that have oestrogen-like activity cause the fish to express the modified gene, making them glow.

When the team tested the fish at eight sites around Hong Kong, they found that some chemicals that showed weak or no oestrogenic activity, including UV filters used in sunscreen, had combined in water to amplify or create an oestrogenic effect. The work is as yet unpublished.

William Price of the University of Wollongong in New South Wales, Australia, warns the approach does not detect a biological response.

http://www.newscientist.com/article/mg21028164.400-fluorescent-fish-glows-to-show-feminising-chemicals-up.html

Nature Uses Screws and Nuts: Previously Unknown Musculoskeletal System Discovered in Weevils



Both parts of the weevil's hip joint fit like screw and nut. This increases the mobility of the leg. (Credit: KIT)

ScienceDaily (July 1, 2011) — A musculoskeletal system so far unknown in the animal world was recently discovered in weevils. The hip of *Trigonopterus oblongus* does not consist of the usual hinges, but of joints based on a screw-and-nut system. This first biological screw thread is about half a millimeter in size and was studied in detail using synchrotron radiation. The discovery is reported by the current issue of the Science magazine.

"Such a construction for animal leg movement is quite unusual, as large areas of skeletal parts move on top of each other. Supply of the leg takes place via a very small opening in the center of the screw," Thomas van de Kamp from Karlsruhe Institute of Technology says. In nature, hips and shoulders usually are based on ball-and-socket systems or hinges that can be operated more easily by organisms. Screws and nuts are known from engineering and used for the fixed connection of components. "Now, we found that nature was first in inventing screws and nuts, because weevils have been using this construction for about 100 million years already," Alexander Riedel from the Karlsruhe State Museum of Natural History says. This museum supplied the weevil samples studied. The detailed three-dimensional images of the joints were made at the national ANKA synchrotron radiation source of Karlsruhe Institute of Technology.

As a rule, weevils are clumsier than many other beetles, e.g. cara-bidae. Transformation of a hinge joint into a screw joint, however, allowed them to move their legs further down, which made them better climbers. The *Trigonopterus oblongus* weevil analyzed here lives on twigs and foliage in the jungle of Papua New Guinea. For feeding, the thorn is pushed into the plant tissue, while the hind legs provide strong foothold. Presumably, the screw joint also is advan-tageous in this respect.

"Meanwhile, we have also studied other weevil species and always found screw joints," explain Riedel and van de Kamp. "Obviously, this joint exists in all weevils, of which more than 50,000 species exist worldwide." In this case, the researchers would have identified the screw joint to be a so far unknown basic feature of the weevil family. The best known species in Germany are curculio nucum and curculio glandium as well as the corn weevil, a grain pest.

The three-dimensional image reconstructions of the joint of Trig-onopterus oblongus of half a millimeter in size were made by means of the newly installed microtomograph of the ANKA synchrotron radiation source. "It extends the existing ensemble of synchrotron imaging techniques for wide application in life sciences," says Tilo Baumbach, Head of the ANKA synchrotron radiation source. "External users can now apply modern systems, from long-wave terahertz radiation to the highly brilliant X-radiation used in this case."

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Karlsruhe Institute of Technology**.

Journal Reference:

1. T. van de Kamp, P. Vagovic, T. Baumbach, A. Riedel. **A Biological Screw in a Beetle's Leg**. *Science*, 2011; 333 (6038): 52 DOI: 10.1126/science.1204245

http://www.sciencedaily.com/releases/2011/07/110701082802.htm

The end of ageing: Why life begins at 90

- 10 August 2011 by **Michael R. Rose**
- Magazine issue 2824.

Time to stop ageing (Image: Britt Erlanson/Stone/Getty)

Live long enough and your body stops ageing – so can we learn to stop the clock before our twilight years?

IN 1939, British statisticians Major Greenwood and J. O. Irwin published a little-noticed article in the journal *Human Biology*. Not only was 1939 a bad year for making scientific history, their article contained some fearsome mathematics, guaranteed to scare away most biologists and doctors.

The article also contained a profoundly unexpected discovery. Greenwood and Irwin were studying mortality figures for women aged 93 and over. They expected to see the death rate rising with age, as it does throughout adult life. But they did not. Instead, between 93 and 100 years of age the acceleration in death rates came to a screeching stop. Little old ladies aged 99 were no more likely to die than those aged 93.

Even the authors were dismayed. "At first sight this must seem a preposterous speculation," they wrote. After all, like every other respectable biologist of the time, they assumed that "decay must surely continue".

But what if it doesn't? What if ageing stops? And if it stops very late in our lives, is there any way we can make it stop earlier, when we are in better health?

The idea that ageing stops makes very little intuitive sense. The fact of ageing has been well known to biology and medicine from their earliest days. Aristotle wrote a good book on the topic more than 2300 years ago. Like pretty much every biologist since then, he thought of ageing as a remorseless process of falling apart, until death finally puts us out of our misery. Present molecular and cell theories of ageing still assume that ageing is a physiological process involving some type of cumulative damage, disrepair or disharmony. The theories differ only over which specific kind of cumulative breakdown happens. Evolutionary biologists like myself who work on ageing likewise used to think that we were studying how natural selection might allow the cumulative damage to happen.

All that started to change in 1992, when the labs of Jim Carey at the University of California, Davis, and Jim Curtsinger at the University of Minnesota independently published landmark articles in the journal *Science* (vol 258, p 457 and p 461).

One big problem with the 1939 research was that Greenwood and Irwin were using human data, and humans are bad experimental animals. People aren't willing to live in laboratory cages - and they live a long time. They also tend to live out the latter part of their lives in relative comfort. Perhaps the levelling off of mortality was merely an effect of the benefits of nursing care.

Dropping like flies

Carey and Curtsinger studied not humans but those stalwarts of the lab, flies - hundreds of thousands of them. They kept groups of thousands of flies of the same age in carefully controlled conditions and meticulously recorded the death of every single fly until the whole group was dead.

Amazingly, they found the same thing as Greenwood and Irwin: at first the mortality rate increased exponentially, but after a few weeks death rates stopped rising. Some of Carey's results were breathtaking: once death rates levelled off, there were months of stable or even declining death rates (see diagram). It looked as if a relatively brief period of ageing was followed by a long plateau when ageing stopped. This time, everybody noticed.

Soon other biologists were looking for signs of life after ageing. To our collective astonishment, they were found in every laboratory experiment of sufficient size, whether flies, nematode worms or beetles. Admittedly, there aren't very many studies that have used large enough cohorts to see the effect, and nobody has done it in mice or other mammals. But that merely showed why we hadn't noticed it before: almost no one had thought to keep large enough cohorts to measure death rates at later ages accurately. Once we started doing experiments on the right scale, it was obvious that what Greenwood and Irwin found in their old ladies was generally true: look late enough in the ageing process and it seems to stop. There is a "third phase" of life after adulthood characterised by stable mortality rates. And that just didn't make sense.

For me, as an evolutionary biologist who had been working on ageing for 15 years prior to 1992, confronting the Carey and Curtsinger results was like a near-death experience. My mind reeled.

At the time my view of ageing as unrelenting decline was informed by the work of the great evolutionary theorist William Hamilton, specifically his 1966 mathematical model of how the ageing process evolved (*Journal of Theoretical Biology*, vol 12, p 12).

Hamilton reasoned that in early life, any gene that kills an organism before it can reproduce will be ruthlessly weeded out by natural selection, since that individual will fail to leave offspring. But genes that kill only later in life are not weeded out as rigorously, so they can hang around in the population. By this reckoning, ageing evolved as a result of "declining forces of natural selection" as individuals get older.

Evolutionists universally interpreted this as proof that unrelenting ageing was inevitable. Our basic interpretation of Hamilton's work was that once an individual reached an age at which bad genes have no further impact on reproductive success, the protective force of natural selection would reach zero and survival would completely collapse. It was supposed to be like walking off a cliff. Yet here we were with evidence that ageing actually stopped.

I spent two uneasy years thinking about the problem. Then I had an idea; a hopeful speculation. What if our interpretation of Hamilton's work was wrong? What if ageing was actually caused by the declining forces of

natural selection? If so, once these forces bottomed out, the ageing process too would stop. I did not have a full explanation - it was just an intuition. But I knew how to test it.

My colleague Larry Mueller is a gifted computer modeller and statistician, as well as an evolutionist. Plus his office is next to mine. I asked him to run some computer models of the ageing process incorporating this new interpretation of Hamilton's mathematics. My hope was that under some circumstances, evolution might allow ageing to stop late in life, at least theoretically.

The surprising thing was that in every case we ran, ageing came to a stop. It looked like the conclusion that evolutionary theory required unending ageing was wrong. Quite the opposite, in fact (*Proceedings of the National Academy of Sciences*, vol 93, p 15294).

So we decided to push the idea further. Could we predict the evolution of different stopping points for ageing? Again, the answer was yes. It turned out that the last age at which a population is allowed to reproduce over many generations is key. If reproduction stops earlier, so too does ageing. Stop reproduction later and ageing follows suit. So not only did we have a theory of why ageing could stop, we could test it experimentally.

Now the burden was on me and my lab. Fortunately I already had dozens of fly populations in which we had tightly controlled last ages of reproduction for hundreds of generations. We compared the ageing patterns of these different populations in extremely large experiments featuring months of daily observations of many thousands of flies by hundreds of students. No one else had done anything on this scale. Not for nothing do the people in my department call my lab "the sweatshop".

The results were striking. Exactly as the models predicted, populations with an earlier last age of reproduction stopped ageing earlier and lived longer, and vice versa (*Evolution*, vol 56, p 1982).

That was encouraging, but it did not rule out another interpretation that Greenwood and Irwin first offered in 1939. Perhaps the end of ageing is an illusion caused by individual differences in robustness. In each population of flies there are a few Supermen, a few Woody Allens, and everything in between. The feeble die off first, leaving only the super-robust. These would be the sole survivors at later ages, making it look as if ageing has sharply decelerated.

Biologists have been looking for this "lifelong heterogeneity" for years, but have yet to find it. My doctoral student Cassie Rauser did a series of experiments but found only evidence against it. For now, only the model that Mueller and I proposed has significant experimental support.

We still don't have a full explanation of the underlying genetics of the cessation of ageing. One possibility is that there are genes that are advantageous early on but damaging to health later in life - an effect called "antagonistic pleiotropy". We are making progress on this, but in any case the fruit fly experiments tell us that the effect is real.

We now understand that ageing is not a cumulative process of progressive chemical damage, like rust. It is a pattern of declining function produced by evolution. Aristotle was wrong, and so are all the present-day biologists who try to explain ageing in terms of biochemistry or cell biology alone.

All this work on life after ageing is documented in detail in the book *Does Aging Stop?*. But it is only the start of what I see as a revolution in our understanding of ageing - and our manipulation of it.

A decade ago, I proposed that it would be more useful if we could stop ageing early rather than slow its progression. The effect on lifespan, and still more on "healthspan", would be much greater. If we could stop

human ageing in middle rather than old age - which is what happens in flies - useful and enjoyable life could be extended indefinitely and the health burdens of decrepitude avoided.

Back then I had no idea how to bring that about. Now, in *Does Aging Stop?* and at my website 55theses.org, we have proposed one way by which it might be possible.

The starting point is the idea that the forces of natural selection decline with age. That means you are best adapted to your environment when you are young, and less so when you are old. Or to put it another way, ageing can be seen as progressive decline in adaptedness as you get older.

But this is not the only factor. Building adaptations takes time, particularly in response to environmental change. So environmental change can add to the decline in adaptation, and thus health, with age. This is very relevant to humans. It is only relatively recently that our species underwent a major environmental change - the switch to an agricultural way of life and a diet based on grasses and dairy produce. This, I propose, may be the reason we make the shift to a post-ageing life at such a late age.

Given the declining forces of natural selection, we can expect to be well adapted to agricultural diet at early ages but less so at later ages. This has the effect of amplifying the decline in adaptedness that we experience as we get older. On top of that, the adoption of an agricultural way of life may have increased human fertility at later ages and pushed back the last age at reproduction - and we know from the fly experiments that this can lead to a later transition to the late-life plateau.

To improve the course of our ageing, and to stop it earlier, we need to pay close attention to our evolutionary history. This is of course complicated, but there are a few guidelines that offer possibilities.

The simplest human evolutionary history is that of individuals whose ancestors never lived under agricultural or industrial conditions. This is a small minority, but their ageing is important for understanding the possibilities for the rest of us. People from Papua New Guinea, whose ancestors were only exposed to agricultural foods and lifestyles during the past century, will not be well-adapted to them. In his 2009 book *Food and Western Disease*, Staffan Lindeberg of the University of Lund in Sweden documents the health benefits such people can reap by reverting to their ancestral hunter-gatherer diets. Calculations Larry Mueller did for *Does Aging Stop?* support the idea that people with hunter-gatherer ancestry should be able to stop ageing much earlier by switching to their ancestral lifestyle and diet.

For the rest of us the picture is more complicated, as we are somewhat adapted to agricultural diets thanks to our ancestors' exposure to them over the past 10,000 years. But the greater force of natural selection at early ages implies that we are best adapted to this environment when we are young, perhaps under 30. At later ages, there may have been too few generations of natural selection, and natural selection may not have been strong enough, to adapt us to that lifestyle. So it may be beneficial to our health to switch to the diet and activity levels of hunter-gatherers.

I have been following such a diet - essentially avoiding grass-derived foods, such as grains, rice, corn and sugar cane, and anything made from milk - for two years and the results have been good.

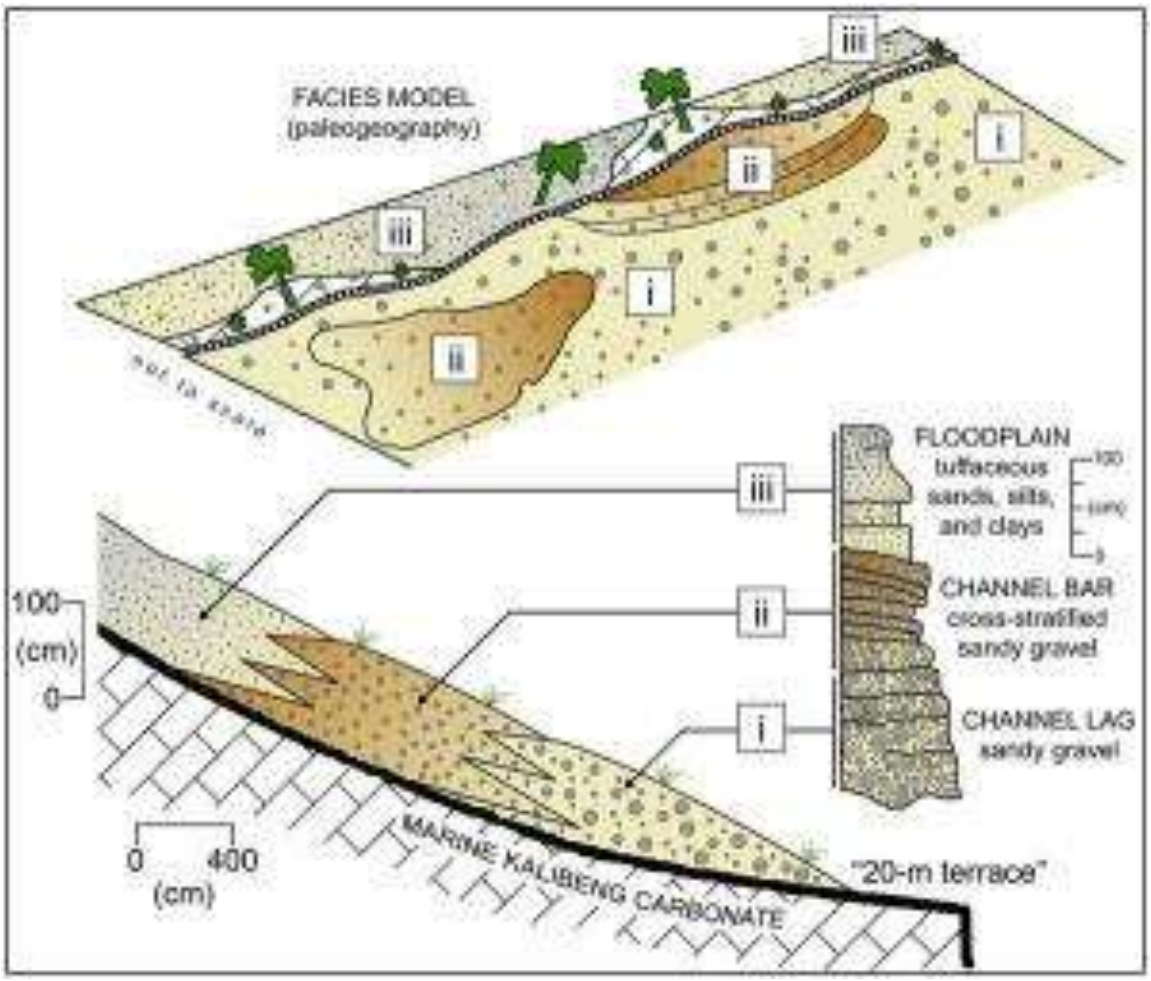
I am not suggesting that everyone, at every age, should adopt a Stone-Age diet, as those who embrace the "Paleo" doctrine advocate. We are well-adapted to wheat, rice and corn when we are young and can eat them with impunity. But, I propose, not when we are older. The benefits for most of us will probably not be as dramatic as those for people who have no agricultural ancestry. But even reduced benefits offer the possibility of warming the chilly draughts of death.

The existence of an age at which human ageing stops is no longer questionable, nor is its potential malleability. The discovery that ageing stops suggest that the age-old desire to radically extend the human lifespan is a real possibility.

Michael R. Rose *is professor of evolutionary biology at the University of California, Irvine. For more on this topic, consult Does Aging Stop? by Laurence D. Mueller, Casandra L. Rauser and Michael R. Rose (Oxford University Press). For a less technical but still extensive discussion, visit 55theses.org*

http://www.newscientist.com/article/mg21128241.900-the-end-of-ageing-why-life-begins-at-90.html

Human Ancestor Older Than Previously Thought; Finding Offers New Insights Into Evolution



Generalized composite sedimentary geology of the Ngandong and Jigar "20 meter terrace" denoting stratigraphic positions of Homo erectus fossil material and dated pumices. (Credit: Etty Indriati, Carl C. Swisher, Christopher Lepre, Rhonda L. Quinn, Rusyad A. Suriyanto, Agus T. Hascaryo, Rainer Grün, Craig S. Feibel, Briana L. Pobiner, Maxime Aubert, Wendy Lees, Susan C. Antón. The Age of the 20 Meter Solo River Terrace, Java, Indonesia and the Survival of Homo erectus in Asia. PLoS ONE, 2011; 6 (6): e21562 DOI: 10.1371/journal.pone.0021562)

ScienceDaily (June 30, 2011) — Modern humans never co-existed with Homo erectus -- a finding counter to previous hypotheses of human evolution -- new excavations in Indonesia and dating analyses show. The research, reported in the journal *PLoS ONE*, offers new insights into the nature of human evolution, suggesting a different role for Homo erectus than had been previously thought.

The work was conducted by the Solo River Terrace (SoRT) Project, an international group of scientists directed by anthropologists Etty Indriati of Gadjah Mada University in Indonesia and Susan Antón of New York University.

Homo erectus is widely considered a direct human ancestor -- it resembles modern humans in many respects, except for its smaller brain and differently shaped skull -- and was the first of our ancestors to migrate out of Africa, approximately 1.8 million years ago. Homo erectus went extinct in Africa and much of Asia by about 500,000 years ago, but appeared to have survived in Indonesia until about 35,000 to 50,000 years ago at the site of Ngandong on the Solo River. These late members of Homo erectus would have shared the environment with early members of our own species, Homo sapiens, who arrived in Indonesia by about 40,000 years ago.

The existence of the two species simultaneously has important implications for models about the origins of modern humans. One of the models, the Out of Africa or replacement model, predicts such overlap. However, another, the multiregional model, which posits that modern humans originated as a result of genetic contributions from hominin populations all around the Old World (Africa, Asia, Europe), does not. The late survival of Homo erectus in Indonesia has been used as one line of support for the Out of Africa model. However, findings by the SoRT Project show that Homo erectus' time in the region ended before modern humans arrived there. The analyses suggest that Homo erectus was gone by at least 143,000 years ago -- and likely by more than 550,000 years ago. This means the demise of Homo erectus occurred long before the arrival of Homo sapiens.

"Thus, Homo erectus probably did not share habitats with modern humans," said Indriati.

The SoRT Project's investigations occurred in Ngandong and Jigar, two sites in the "20-meter terrace" of the Solo River, Indonesia. The sediments in the terrace were formed by the flooding of the ancient river, but currently sit above the Solo River because the river has cut downward through time. The terrace has been a rich source for the discovery of Homo erectus and other animal fossils since the 1930s.

As recently as 1996, a research team dated these sites of hominin, or early human, fossils to as young as 35,000-50,000 years old. The analyses used a technique that dates teeth, and thus provided ages for several animals discovered at the sites. However, other scholars suggested the sites included a mixture of older hominins and younger animals, raising questions about the true age of the hominin remains.

The goal of the SoRT team, which included both members of the 1996 group and its critics, was to understand how the sites in the terrace formed, whether there was evidence for mixing of older and younger remains, and just how old the sites were.

Since 2004, team members have conducted analyses of animal remains, geological surveys, trenching, and archaeological excavations. The results from all of these provide no evidence for the mixing of older and younger remains. All the evidence suggests the sites represent just a short time period.

"The postmortem damage to the animal remains is consistent and suggests very little movement of the remains by water," explained Briana Pobiner, the project's archaeologist and a paleoanthropologist at the Smithsonian Institution's National Museum of Natural History. "This means that it is unlikely that very old remains were mixed into younger ones."

In addition, clues from the sediments exposed during excavation suggest to the projects' geoarchaeologists, Rhonda Quinn, Chris Lepre, and Craig Feibel, of Seton Hall, Columbia, and Rutgers universities, that the deposits occurred over a short time period. The teeth found in different excavation layers at Jigar are also all nearly identical in age, supporting the conclusion that mixing across geological periods did not occur.

"Whatever the geological age of the sites is, the hominins, animals, and sediments at Ngandong and Jigar are all the same age," said project co-leader Susan Antón.

The team applied two different dating techniques to the sites. Like earlier work, they used the techniques -- U-series and Electron Spin Resonance, or ESR -- that are applied to fossilized teeth. They also used a technique called argon-argon dating that is applied to volcanic minerals in the sediments. All three methods use radioactive decay in different ways to assess age and all yielded robust and methodologically valid results, but the ages were inconsistent with one another.

The argon-argon results yielded highly precise ages of about 550,000 years old on pumices -- very light, porous volcanic products found at Ngandong and Jigar.

"Pumices are hard to rework without breaking them, and these ages are quite good, so this suggests that the hominins and fauna are this old as well," said project geochronologist Carl Swisher of Rutgers University.

By contrast, the oldest of the U-series and ESR ages, which were conducted at Australian National University by Rainer Grün, are just 143,000 years.

The difference in the ages means that one of the systems is providing an age for something other than the formation of the sites and fossils in them. One possibility is that the pumices are, in fact, reworked, or mixed in, from older rocks. The other possibility is that the ESR and U-series ages are dating an event that occurred after the sites were formed, perhaps a change in the way groundwater moved through the sites.

Either way, the ages provide a maximum and a minimum for the sites -- and both of these ages are older than the earliest Homo sapiens fossils in Indonesia. Thus, the authors concluded that the idea of a population of Homo erectus surviving until late in time in Indonesia and potentially interacting with Homo sapiens seems to have been disproven.

The study's other co-authors included: Rusyad Suriyanto and Agus Hascaryo of Indonesia's Gadjah Mada University and Wendy Lees and Maxime Aubert of the Australian National University.
The National Science Foundation sponsored field and laboratory work by the Solo River Terrace Project.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **New York University**.

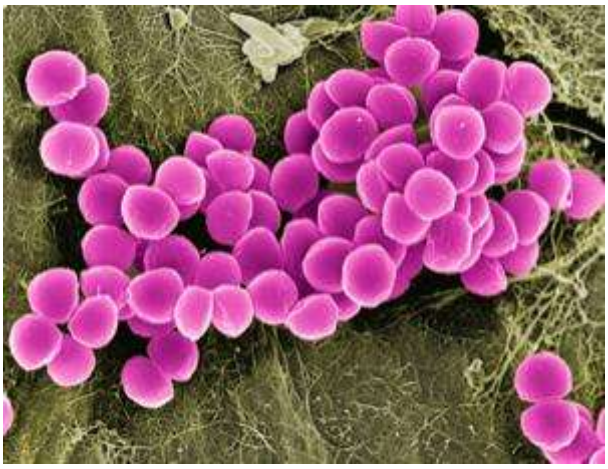
Journal Reference:

1. Etty Indriati, Carl C. Swisher, Christopher Lepre, Rhonda L. Quinn, Rusyad A. Suriyanto, Agus T. Hascaryo, Rainer Grün, Craig S. Feibel, Briana L. Pobiner, Maxime Aubert, Wendy Lees, Susan C. Antón. **The Age of the 20 Meter Solo River Terrace, Java, Indonesia and the Survival of Homo erectus in Asia**. *PLoS ONE*, 2011; 6 (6): e21562 DOI: 10.1371/journal.pone.0021562

http://www.sciencedaily.com/releases/2011/06/110629181853.htm

Superbugs may be here to stay

- 17:54 29 July 2011 by **Andrew Purcell**



MRSA may be here to stay (Image: Dr. Stanley Fleger/ Visuals Unlimited, Inc./Getty)

Multidrug-resistant bacteria may be here to stay. The common wisdom that superbugs with antibiotic resistance are outcompeted by their non-super neighbours in the absence of antibiotics has been turned on its head.

Bacterial antibiotic resistance is a major concern because it can lead to the appearance of dangerous and difficult-to-treat infections in humans. Resistance generally occurs in one of two ways: either through mutations in the bacterial DNA or, more commonly, through the acquisition of resistant genes from other organisms through horizontal gene transfer.

In both cases, previous studies had found that the superbugs lose their competitive advantage once the antibiotics are no longer present. For instance, a voluntary ban by Danish farmers on the use of antibiotic growth promoters in chicken and pigs cut antibiotic resistance in the bacteria within the animals by over 90 per cent.

This is largely because maintaining a newly acquired chunk of DNA from another organism – or coping with a new mutation that imparts antibiotic resistance – uses up so many of the cell's resources, says Francisco Dionísio at the University of Lisbon, Portugal. That means the superbug cannot compete with non-resistant bacteria once the antibiotic has been removed and the playing field has been levelled.

But now Dionísio and colleagues have found that this is not always the case. The team focused on 10 strains of *Escherichia coli* bacteria that had already acquired genes for antibiotic resistance from other organisms.

Super superbug

When these bacteria independently evolved one of five DNA mutations also associated with antibiotic resistance, something peculiar happened: in five of the 50 resulting strains the bacteria could outcompete typical non-resistant bacteria when both were grown in a dish, even in the absence of antibiotics.

A similar thing happened when the team began with *E. coli* that had first acquired resistance to antibiotics through genetic mutation and then gained further resistance by acquisition of a resistance-carrying genetic element from another organism. This time 32 per cent of the superbug strains remained more competitive than the non-resistant bacteria once the antibiotic had been removed.

This kind of process is known as positive epistasis, says Dionísio – but he adds that why two negative impacts on a microbes' fitness should work together to give a positive boost to its survival rate "remains a mystery".

"It was a real surprise to find so many cases where the multi-resistant bacteria were at an advantage," says Isabel Gordo, a member of the team based at the Gulbenkian Science Institute in Oeiras, Portugal. "We suspect that this is very important in maintaining antibiotic resistance at the high levels currently seen."

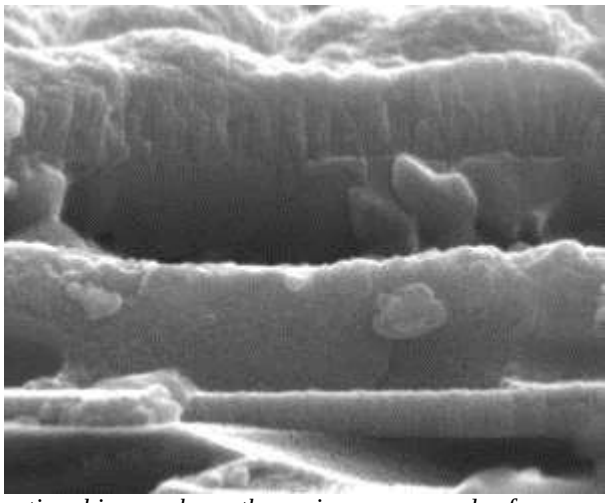
Jim Caryl, an antibiotic resistance researcher at the University of Leeds, UK, says that the problem could be tackled by always using the antibiotics that have the highest fitness cost to the bacteria. This should reduce the chance of positive epistasis emerging, he says.

Dionísio disagrees: what's really needed is an alternative to antibiotics, he says. "We need drugs which will stop the transfer of genetic elements between bacteria – it's amazing that we still don't have a good way of doing this."

Journal reference: *PLoS Genetics*, DOI: 10.1371/journal.pgen.1002181

http://www.newscientist.com/article/dn20749-superbugs-may-be-here-to-stay.html

Inkjet Printing Could Change the Face of Solar Energy Industry



Solar cell. This scanning electron microscope, cross-sectional image shows the various compounds of a new chalcopyrite solar cell only a few microns thick, which can be created much less expensively with inkjet printing. (Credit: Oregon State University)

ScienceDaily (June 28, 2011) — Inkjet printers, a low-cost technology that in recent decades has revolutionized home and small office printing, may soon offer similar benefits for the future of solar energy. Engineers at Oregon State University have discovered a way for the first time to create successful "CIGS" solar devices with inkjet printing, in work that reduces raw material waste by 90 percent and will significantly lower the cost of producing solar energy cells with some very promising compounds.

High performing, rapidly produced, ultra-low cost, thin film solar electronics should be possible, scientists said.

The findings have been published in *Solar Energy Materials and Solar Cells*, a professional journal, and a patent applied for on the discovery. Further research is needed to increase the efficiency of the cell, but the work could lead to a whole new generation of solar energy technology, researchers say.

"This is very promising and could be an important new technology to add to the solar energy field," said Chih-hung Chang, an OSU professor in the School of Chemical, Biological and Environmental Engineering. "Until now no one had been able to create working CIGS solar devices with inkjet technology."

Part of the advantage of this approach, Chang said, is a dramatic reduction in wasted material. Instead of depositing chemical compounds on a substrate with a more expensive vapor phase deposition -- wasting most of the material in the process -- inkjet technology could be used to create precise patterning with very low waste.

"Some of the materials we want to work with for the most advanced solar cells, such as indium, are relatively expensive," Chang said. "If that's what you're using you can't really afford to waste it, and the inkjet approach almost eliminates the waste."

One of the most promising compounds and the focus of the current study is called chalcopyrite, or "CIGS" for the copper, indium, gallium and selenium elements of which it's composed. CIGS has extraordinary solar efficiency -- a layer of chalcopyrite one or two microns thick has the ability to capture the energy from photons about as efficiently as a 50-micron-thick layer made with silicon.

In the new findings, researchers were able to create an ink that could print chalcopyrite onto substrates with an inkjet approach, with a power conversion efficiency of about 5 percent. The OSU researchers say that with continued research they should be able to achieve an efficiency of about 12 percent, which would make a commercially viable solar cell.

In related work, being done in collaboration with Greg Herman, an OSU associate professor of chemical engineering, the engineers are studying other compounds that might also be used with inkjet technology, and cost even less.

Some approaches to producing solar cells are time consuming, or require expensive vacuum systems or toxic chemicals. OSU experts are working to eliminate some of those roadblocks and create much less costly solar technology that is also more environmentally friendly. New jobs and industries in the Pacific Northwest could evolve from such initiatives, they say.

If costs can be reduced enough and other hurdles breached, it might even be possible to create solar cells that could be built directly into roofing materials, scientists say, opening a huge new potential for solar energy.

"In summary, a simple, fast, and direct-write, solution-based deposition process is developed for the fabrication of high quality CIGS solar cells," the researchers wrote in their conclusion. "Safe, cheap, and air-stable inks can be prepared easily by controlling the composition of low-cost metal salt precursors at a molecular level."

This work was supported by the Daegu Gyeongbuk Institute of Science and Technology, the U.S. Department of Energy and OSU's University Venture Development Fund, which helps donors receive tax benefits while sponsoring projects that will bring new technology, jobs and economic growth to Oregon.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Oregon State University**.

Journal Reference:

1. Wei Wang, Yu-Wei Su, Chih-hung Chang. **Inkjet printed chalcopyrite CuInxGa1−xSe2 thin film solar cells**. *Solar Energy Materials and Solar Cells*, 2011; 95 (9): 2616 DOI: 10.1016/j.solmat.2011.05.011

http://www.sciencedaily.com/releases/2011/06/110628133022.htm

Electric dolphins: cetaceans with a seventh sense

- 00:01 27 July 2011 by **Rowan Hooper**

I sing the dolphin electric (Image: A. Liebschner)

One extra sense isn't quite enough for Guiana dolphins. In addition to echolocation, they can sense the electric fields of their prey – the first time this has been seen in true mammals.

Wolf Hanke at the University of Rostock in Germany and colleagues were intrigued by thermal images showing intense physiological activity in the pits on the upper jaw of the dolphins, *Sotalia guianensis*. Fish, some amphibians and primitive egg-laying mammals such as the duck-billed platypus use similar pits to pick up electric fields generated by nearby animals.

By examining the structures in a dead dolphin, and training a live one to respond to an electric field comparable to that generated by a fish, the team showed that dolphins also have electro-sensory perception.

"Electroreception is good for sensing prey over short distances, where echolocation isn't so effective," says Hanke. Other species of dolphin, and even whales, may be similarly gifted, he says. "Most people don't realise that whales also feed on the floor of the ocean, so it is possible that they also use electrosensing."

Hanke points out that the electro-sensory organs are derived from whiskers in ancestral animals. These mechanoreceptor organs, like the hair cells in the human ear, mechanically transmit the stimulus of touch or

sound waves. The adaptation in Guiana dolphins is fairly new, Hanke says, and he suspects that "it is relatively easy to evolve, to change mechanoreceptor organs into electroreceptors".

Indeed, the finding suggests nearly all mammals have at least the potential to evolve it too.

Journal reference: *Proceedings of the Royal Society B*, DOI: 10.1098/rspb.2011.1127

http://www.newscientist.com/article/dn20732-electric-dolphins-cetaceans-with-a-seventh-sense.html

Ancient Symbiosis Between Animals and Bacteria Discovered

This is the flatworm Paracatenula urania from the Belize Barrier Reef in the West Caribbean. (Credit: Harald Gruber-Vodicka)

ScienceDaily (June 28, 2011) — Marine shallow water sandy bottoms on the surface appear desert-like and empty, but in the interstitial space between the sand grains a diverse fauna flourishes. In addition to bacteria and protozoa numerous animal phyla have been found here, some only here. One of the strangest members of this interstitial fauna is *Paracatenula*, a several millimeters long, mouth and gut-less flatworm, which is found from tropical oceans to the Mediterranean. These worms are the focus of a research project led by Jörg Ott at the Department of Marine Biology of the University of Vienna with funding from the Austrian Science Foundation (FWF).

The surprising results of this research have now been published in the journal *Proceedings of the National Academy of Sciences* (*PNAS*).

In the early 1970s, at the time of the discovery of *Paracatenula*, it was already a mystery how the worms acquire their food without a mouth and gut. The solution to this question came unexpectedly: At deep ocean hot vents, giant mouth-less tubeworms were found. These -- like *Paracatenula* -- live in symbiosis with intracellular bacteria that oxidize reduced sulfur compounds. The energy obtained in this chemical process is used by the symbionts to fix inorganic carbon into biomass -- just like plants do using sunlight. Due to the high productivity of the symbionts, their hosts can derive all their nutrition from them.

Many animals of different phyla from several habitats have been found to live in such a symbiotic association. Compared to the great diversity of these hosts, the diversity of the microbial symbionts was strictly limited to members of only two classes, the Gamma and Epsilon Proteobacteria.

***Paracatenula* has Alpha-Proteobacterial "Riegeria" symbionts**

One of the biggest surprises in the current study was that the symbionts of *Paracatenula* are indeed sulfur-oxidizing bacteria, but they are Alpha-Proteobacteria. Several other important intracellular symbionts come from this class, most notably the mitochondria, which are the crucial power plants in the cells of all higher organisms. The nitrogen-fixing root nodule bacteria of leguminous plants, as well as dangerous pathogens such as the causative agent of epidemic typhus, also belong to this class. In recent years several studies have presented evidence that the mechanisms in symbiotic and pathogenic relationships are similar or even identical. Future projects with *Paracatenula* and its symbionts called "Riegeria" could give fundamental insights into the mechanisms that have allowed Alpha-Poteobacteria several times to establish an intracellular lifestyle independently.

Another captivating detail of the *Paracatenula Riegeria* symbiosis is that the symbionts that live in specialized cells called Bacteriocytes account for up to 50 percent of the total tissue. That is significantly more than in all other known symbioses between animals and bacteria.

The *Paracatenula-Riegeria* symbiosis is 500 million years old

Based on genetic sequences of the symbionts the scientists have roughly extrapolated the age of the symbiosis -- the estimated age of 500 million years makes this symbiosis the oldest known animal bacteria association.

Comparing the phylogenies of hosts and symbionts, another subtle but non trivial detail was uncovered -- the worms have been passing on their symbionts to their offspring in every generation, without any symbiont switches for the last 500 million years. How this secured symbiont transmission is accomplished is the focus of the current studies in Jörg Ott's lab.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Vienna**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Harald Ronald Gruber-Vodicka, Ulrich Dirks, Nikolaus Leisch, Christian Baranyi, Kilian Stoecker, Silvia Bulgheresi, Niels Robert Heindl, Matthias Horn, Christian Lott, Alexander Loy, Michael Wagner, and Jörg Ott. **Paracatenula, an ancient symbiosis between thiotrophic Alphaproteobacteria and catenulid flatworms**. *Proceedings of the National Academy of Sciences*, June 27th, 2011

http://www.sciencedaily.com/releases/2011/06/110627151722.htm

Stone Age toe could redraw human family tree

- 10 August 2011 by **Colin Barras**

Magazine issue 2825.

Uncovering family secrets (Image: Bence Viola/MPI/EVA)

ON THE western fringes of Siberia, the Stone Age Denisova cave has surrendered precious treasure: a toe bone that could shed light on early humans' promiscuous relations with their hominin cousins.

New Scientist has learned that the bone is now in the care of Svante Pääbo at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, who revealed the first genetic evidence of interbreeding between ancient humans and other hominins (*New Scientist*, 30 July, p 34).

There are tantalising hints that the find strengthens the case for a third major group of hominins circulating in Eurasia at the same time as early humans and the Neanderthals. It might possibly even prove all three groups were interbreeding (see diagram).

The Denisova cave had already yielded a fossil tooth and finger bone, in 2000 and 2008. Last year, Pääbo's DNA analysis suggested both belonged to a previously unknown group of hominins, the Denisovans. The new bone, an extremely rare find, looks likely to belong to the same group.

It is a very exciting discovery, says Isabelle De Groote at London's Natural History Museum. "Hominin material from southern Siberia is rare and usually extremely fragmentary."

The primitive morphology of the 30,000 to 50,000-year-old Denisovan finger bone and tooth indicates that Denisovans separated from the Neanderthals roughly 300,000 years ago. At the time of the analysis, Pääbo speculated that they came to occupy large parts of east Asia at a time when Europe and western Asia were dominated by Neanderthals. By 40,000 years ago, *Homo sapiens* was also moving around much of the region. But the Denisovans remain known only from the finger and tooth fossils - not enough information to formally assign them to their own species.

That may change with analysis of the newly discovered toe bone. It was found in the same layer of the cave floor as the finger bone, by Maria Mednikova at the Russian Academy of Sciences in Moscow (*Archaeology, Ethnology and Anthropology of Eurasia*, vol 39, p 129).

Mednikova says this suggests it belonged to a contemporary individual, alive roughly 40,000 years ago. But her studies show the finger and toe bones belonged to distinct people. In addition, the toe bone is stocky and its shape is somewhere between that of a modern human and a typical Neanderthal.

Others are less convinced. Erik Trinkaus at Washington University in St Louis, Missouri, who has written extensively on hominin foot bone morphology, says the bone's sturdy appearance is interesting but inconclusive from a taxonomic perspective.

What's needed is DNA evidence. For now, though, Pääbo's team remain very tight-lipped about what, if anything, they have found. "We have no results we are ready to talk about yet," Pääbo told *New Scientist*. Mednikova saw some of the team's preliminary findings last month and promises a "wonderful result" will be published in the near future - although with the analysis still under review she can say no more.

Her enthusiasm suggests that Pääbo's team has successfully extracted DNA from the toe bone, and hints that it shows that this was no ordinary hominin. At the very least, one can presume it doesn't belong to a human or a Neanderthal.

"The Neanderthals came to the Altai mountains [in Siberia] about 45,000 years ago and were probably assimilated by the native Denisovan population," she says. "It cannot be excluded that the individual was Denisovan, Neanderthal or even a hybrid - why not?"

If the Stone Age toe really did belong to a Neanderthal-Denisovan hybrid, it would be a remarkable find. Pääbo is fast building a reputation for revealing *Homo sapiens*' promiscuous past. He has shown that humans and Neanderthals interbred, as did humans and Denisovans. Until the latest analysis is published, we can only speculate on what has been found. But the human family tree could be about to get even more complicated. If so, there may be a case for reclassifying all three as members of the same species.

http://www.newscientist.com/article/mg21128254.000-stone-age-toe-could-redraw-human-family-tree.html

It's Not an Apple a Day After All -- It's Strawberries: Flavonoids Could Represent Two-Fisted Assault On Diabetes and Nervous System Disorders

Fisetin, a naturally-occurring flavonoid found most abundantly in strawberries, lessens complications of diabetes. (Credit: Courtesy of the Salk Institute for Biological Studies)

ScienceDaily (June 28, 2011) — A recent study from scientists at the Salk Institute for Biological Studies suggests that a strawberry a day (or more accurately, 37 of them) could keep not just one doctor away, but an entire fleet of them, including the neurologist, the endocrinologist, and maybe even the oncologist.

Investigations conducted in the Salk Institute's Cellular Neurobiology Laboratory (CNL) will appear in the June 27, 2011, issue of *PLoS ONE*. The report explains that fisetin, a naturally-occurring flavonoid found most abundantly in strawberries and to a lesser extent in other fruits and vegetables, lessens complications of diabetes. Previously, the lab showed that fisetin promoted survival of neurons grown in culture and enhanced memory in healthy mice. That fisetin can target multiple organs strongly suggests that a single drug could be used to mitigate numerous medical complications.

"This manuscript describes for the first time a drug that prevents both kidney and brain complications in a type 1 diabetes mouse model," says David Schubert, Ph.D., professor and head of the Cellular Neurobiology Laboratory and one of the manuscript's co-authors. "Moreover, it demonstrates the probable molecular basis of how the therapeutic is working."

Pam Maher, Ph.D., a senior staff scientist in the CNL, is the study's corresponding author. Maher initially identified fisetin as a neuroprotective flavonoid ten years ago. "In plants, flavonoids act as sunscreens and protect leaves and fruit from insects," she explains. "As foods they are implicated in the protective effect of the 'Mediterranean Diet.'"

Other celebrity flavonoids include polyphenolic compounds in blueberries and red wine.

Although her group's focus is neurobiology, Maher and colleagues reasoned that, like other flavonoids, fisetin might ameliorate a spectrum of disorders seen in diabetic patients. To test this, they evaluated effects of fisetin supplementation in Akita mice, a very robust model of type 1 diabetes, also called childhood onset diabetes.

Akita mice exhibit increased blood sugar typical of type 1 diabetes and display pathologies seen in serious human complications of both type 1 and 2 diabetes. Those include diabetic nephropathy or kidney disease, retinopathy, and neuropathies in which patients lose touch or heat sensations.

Mice fed a fisetin-enriched diet remained diabetic, but acute kidney enlargement-or hypertrophy-seen in untreated mice was reversed, and high urine protein levels, a sure sign of kidney disease, fell. Moreover, fisetin ingestion ameliorated anxiety-related behaviors seen in diabetic mice. "Most mice put in a large area become exploratory," says Maher. "But anxious mice tend not to move around. Akita mice showed enhanced anxiety behavior, but fisetin feeding restored their locomotion to more normal levels."

The study also defines a likely molecular mechanism underlying these effects. Researchers observed that blood and brain levels of sugars affixed to proteins known as advanced glycation end-products-or AGEs-were reduced in fisetin-treated compared to untreated Akita mice. These decreases were accompanied by increased activity of the enzyme glyoxalase 1, which promotes removal of toxic AGE precursors.

The discovery of an AGE-antagonizing enzyme upregulated by fisetin is very intriguing, because substantial evidence implicates high blood AGE levels with many if not most diabetic complications. "We know that fisetin increases activity of the glyoxalase enzyme and may increase its expression," says Maher. "But what is important is that ours is the first report that any compound can enhance glyoxalase 1 activity."

Interestingly, excessively high AGE levels also correlate with inflammatory activity thought to promote some cancers. In fact, studies published by others confirm that fisetin decreases tumorigenicity of prostate cancer cells both in culture and in animal models, which if supported would represent a major added incentive to eat your strawberries.

To ingest fisetin levels equivalent to those fed Akita mice, Maher estimates that humans would have to eat 37 strawberries a day, assuming that strawberry fisetin is as readily metabolizable by humans as fisetin-spiked lab chow is by mice. Rather than through diet, Maher envisions that fisetin-like drugs could be taken as a supplement.

Schubert notes that fisetin is also effective in mouse models of Alzheimer's disease. "We and others have shown that diabetes may be a risk factor for Alzheimer's disease, making identification of a safe prophylactic like fisetin highly significant," he says.

Maher acknowledges that the public may be suffering from flavonoid-fatigue, given media coverage of the promises of these compounds. "Polyphenolics like fisetin and those in blueberry extracts are found in fruits and vegetables and are related to each other chemically," she says. "There is increasing evidence that they all work in multiple diseases. Hopefully some combination of these compounds will eventually get to the clinic."

Schubert concurs that their findings only reinforce what common sense and our mothers told us was a healthy lifestyle. "Eat a balanced diet and as much freshly prepared organic food as possible, get some exercise, keep socially and mentally active and avoid sodas with sugar and highly processed foods since they can contain high levels of AGEs," he advises.

But he also worries that hoops that must be jumped through to bring a natural product like fisetin, as opposed to a totally synthetic drug, to clinical trials are daunting because it is difficult to protect patents on natural products. "We will never know if a compound like fisetin works in humans until someone is willing to support a clinical trial."

Also contributing to this study were Richard Dargusch and Jennifer L. Ehren, Ph.D.,of the Cellular Neurobiology Laboratory, and Kumar Sharma, M.D., and Shinichi Okada, M.D., Ph.D., of the Department of Medicine at University of California, San Diego.

Funding for the study came from the Fritz B. Burns Foundation, the Juvenile Diabetes Research Foundation, the Hewitt Foundation, and the National Institutes of Health.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Salk Institute**.

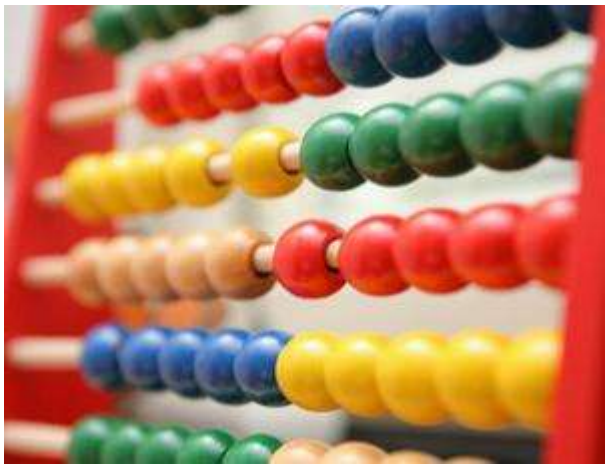
Journal Reference:

1. Pamela Maher, Richard Dargusch, Jennifer L. Ehren, Shinichi Okada, Kumar Sharma, David Schubert. **Fisetin Lowers Methylglyoxal Dependent Protein Glycation and Limits the Complications of Diabetes**. *PLoS ONE*, 2011; 6 (6): e21226 DOI: 10.1371/journal.pone.0021226

http://www.sciencedaily.com/releases/2011/06/110627183932.htm

Mental abacus does away with words

- 13:56 09 August 2011 by **Ferris Jabr**



OK, now transfer it to your mind (Image: F1 Online/Rex Features)

When 11-year-old Priyanshi Somani multiplies strings of 10-digit numbers or finds the square root of a six-digit number, she doesn't use a calculator or even pencil and paper. Instead, like other specially trained youngsters, the young Mental Calculation World Cup champion manipulates an imaginary abacus.

Now studies on a group of children trained to use a "mental abacus" suggest the technique frees mathematics from its usual dependence on language.

In some parts of the world, particularly India, China and Japan, schoolchildren sign up for intense training programmes that teach them how to perform complex calculations in their heads using a mental abacus.

Intrigued, Michael Frank of Stanford University in California and David Barner at the University of California, San Diego, travelled to a school in Vadadora in Gujarat, India, where children learn mental abacus in a 3-year-long after-school programme.

Ali Baba

Previous research has suggested that mental abacus relies on visual working memory, but it wasn't clear how children kept track of all the columns: a typical abacus might have more than 15 columns, yet most people have trouble simultaneously visualising more than three or four distinct items in their minds.

In one experiment, Frank and Barner studied children who had spent a year learning to work a physical abacus and had recently begun practicing mental abacus. The pair asked the students to perform challenging additions. Most of them had difficulty performing calculations with numbers that had more than three or four digits. Frank suggests that the children only represent three or four columns of an abacus in their minds at any given time.

In a second experiment, the pair asked 15 expert mental abacus students to do complex calculations while listening to the story *Ali Baba and the Forty Thieves*. At the same time, these children had to repeat each word of the tale as they heard it – a language task – or drum their fingers on the table – a motor task – or do both.

Visual representation

The language and motor tasks somewhat hindered the expert children's mental calculations, with the language task interfering slightly less than the motor task. In contrast, a group of undergraduates from the University of California with no experience in mental abacus found it almost impossible to perform complex calculations while listening to the story.

All of this suggests that for practiced experts, mental abacus does not depend strongly on language systems, says Frank. Most of us need words to represent a number like 134,789 – we rely on concepts represented by verbal numbers like "seven-hundred and eighty-nine" – but mental abacus may be largely a visual task for those who master it.

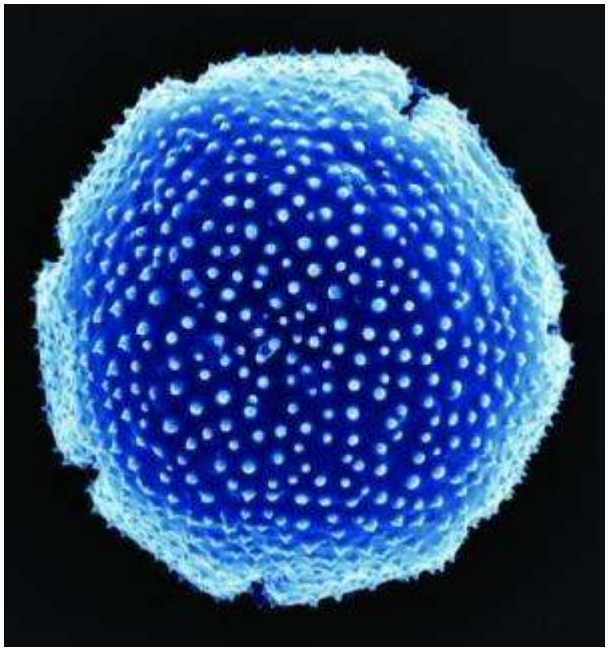
"What we found confirms and extends previous work suggesting that mental abacus is not based on language, but is really a mental image of some sort, a visual representation," Frank adds.

The design of the abacus not only makes it a powerful physical tool, it also facilitates mental visualisation. Grouping beads into a few sets makes them easier to hold in visual memory – just as dividing long telephone numbers into three or four-digit chunks helps us remember them. "Because the physical abacus groups beads into columns, it's easier to hold a mental image of the abacus in your head," says Frank.

Journal reference: *Journal of Experimental Psychology*, DOI: 10.1037/a0024427

http://www.newscientist.com/article/dn20775-mental-abacus-does-away-with-words.html

Fossilized Pollen Reveals Climate History of Northern Antarctica: Tundra Persisted Until 12 Million Years Ago



Researchers ascertained the exact species of plants that existed on the Antarctic Peninsula over the past 36 million years during a three-year examination of thousands of grains of fossilized pollen, including this grain from the tree Nothofagus fusca. (Credit: S. Warny/LSU)

ScienceDaily (June 28, 2011) — A painstaking examination of the first direct and detailed climate record from the continental shelves surrounding Antarctica reveals that the last remnant of Antarctic vegetation existed in a tundra landscape on the continent's northern peninsula about 12 million years ago.

The research, which was led by researchers at Rice University and Louisiana State University, appears online this week and will be featured on the cover of the July 12 issue of the *Proceedings of the National Academy of Sciences.*

The new study contains the most detailed reconstruction to date of the climatic history of the Antarctic Peninsula, which has warmed significantly in recent decades. The rapid decline of glaciers along the peninsula has led to widespread speculation about how the rest of the continent's ice sheets will react to rising global temperatures.

"The best way to predict future changes in the behavior of Antarctic ice sheets and their influence on climate is to understand their past," said Rice University marine geologist John Anderson, the study's lead author. The study paints the most detailed picture to date of how the Antarctic Peninsula first succumbed to ice during a prolonged period of global cooling.

In the warmest period in Earth's past 55 million years, Antarctica was ice-free and forested. The continent's vast ice sheets, which today contain more than two-thirds of Earth's freshwater, began forming about 38 million years ago. The Antarctic Peninsula, which juts farther north than the rest of the continent, was the last part of Antarctica to succumb to ice. It's also the part that has experienced the most dramatic warming in recent decades; its mean annual temperatures rose as much as six times faster than mean annual temperatures worldwide.

"There's a longstanding debate about how rapidly glaciation progressed in Antarctica," said Sophie Warny, a Louisiana State University geologist who specializes in palynology (the study of fossilized pollen and spores) and led the palynological reconstruction. "We found that the fossil record was unambiguous; glacial expansion in the Antarctic Peninsula was a long, gradual process that was influenced by atmospheric, tectonic and oceanographic changes."

Warny, her students and colleague Rosemary Askin were able to ascertain the exact species of plants that existed on the peninsula over the past 36 million years after a painstaking, three-year examination of thousands of individual grains of pollen that were preserved in muddy sediments beneath the sea floor just off the coast.

"The pollen record in the sedimentary layers was beautiful, both in its richness and depth," Warny said. "It allowed us to construct a detailed picture of the rapid decline of the forests during the late Eocene -- about 35 million years ago -- and the widespread glaciation that took place in the middle Miocene -- about 13 million years ago."

Obtaining the sedimentary samples wasn't easy. The muddy treasure trove was locked away beneath almost 100 feet of dense sedimentary rock. It was also off the coast of the peninsula in shallow waters that are

covered by ice most of the year and beset by icebergs the rest. Anderson, a veteran of more than 25 research expeditions to Antarctica, and colleagues spent more than a decade building a case for the funding to outfit an icebreaker with the right kind of drilling equipment to bore through the rock.

In 2002, the National Science Foundation (NSF) funded the project, which was dubbed SHALDRIL. Three years later, the NSF research vessel Nathaniel B. Palmer left on the first of two drilling cruises.

"It was the worst ice year that any of us could remember," Anderson said. "We'd spend most of a day lowering drill string to the ocean floor only to pull it back up to get out of the way of approaching icebergs."

The next year was little better, but the SHALDRIL team managed to obtain enough core samples to cover the past 36 million years, thanks to the logistical planning of marine geologist Julia Wellner and to the skill of the drilling crew. By end of the second season, Anderson said, the crew could drill as much as a meter every five minutes.

Reconstructing a detailed climate record from the sample was another Herculean task. In addition to the three-year palynological analysis at LSU, University of Southampton palaeoceanographer Steven Bohaty led an effort to nail down the precise age of the various sediments in each core sample. Wellner, now at the University of Houston, examined the characteristics of the sediments to determine whether they formed below an ice sheet, in open marine conditions or in a combined glacial-marine setting. Other members of the team had to count, categorize and even examine the surface texture of thousands of sand grains that were preserved in the sediments. Gradually, the team was able to piece together a history of how much of the peninsula was covered by glaciers throughout the past 36 million years.

"SHALDRIL gave us the first reliable age constraints on the timing of ice sheet advance across the northern peninsula," Anderson said. "The rich mosaic of organic and geologic material that we found in the sedimentary record has given us a much clearer picture of the climatic history of the Antarctic Peninsula. This type of record is invaluable as we struggle to place in context the rapid changes that we see taking place in the peninsula today."

The study was funded by grants from the NSF's Office of Polar Programs to Anderson and Warny. Study co-authors include Wellner; Askin; Bohaty; Alexandra Kirshner, Tyler Smith and Fred Weaver, all of Rice; Alexander Simms and Daniel Livsey, both of the University of California, Santa Barbara; Werner Ehrmann of the University of Leipzig; Lawrence Lawver of the University of Texas at Austin; David Barbeau of the University of South Carolina; Sherwood Wise and Denise Kulhenek, both of Florida State University; and Wojciech Majewski of the Polish Academy of Sciences.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Rice University**.

Journal Reference:

1. John B. Anderson, Sophie Warny, Rosemary A. Askin, Julia S. Wellner, Steven M. Bohaty, Alexandra E. Kirshner, Daniel N. Livsey, Alexander R. Simms, Tyler R. Smith, Werner Ehrmann, Lawrence A. Lawver, David Barbeau, Sherwood W. Wise, Denise K. Kulhenek, Fred M. Weaver, Wojciech Majewski. **Progressive Cenozoic cooling and the demise of Antarctica's last refugium**. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1014885108

http://www.sciencedaily.com/releases/2011/06/110627163508.htm

Somali archaeologist: We need culture in a time of war

- 08 August 2011 by **Curtis Abraham**

Magazine issue 2824.

Rescuing Somali heritage (Image: Jason Bye)

*As a child she was forced to flee Somalia. Now **Sada Mire** is back, uncovering ancient rock art and ruined towns. She told **Curtis Abraham** what it's like to be the only working archaeologist in the region, and why she believes cultural heritage remains a priority even in times of war and famine*

What was life like growing up in Somalia?
I grew up in the 1980s in the Medina area of Mogadishu, a multicultural east African town with Somalis, Kenyans, Italians, Arabs and descendants of Chinese merchants. My father was a police officer and my mother was a midwife. Despite hardships and violence at the hands of the Mohamed Siad Barre dictatorship - my father was arrested and tortured several times, and my sister and I were expelled from school due to clan discrimination - I thought at the time that I had a normal childhood. My parents did all they could to shield us and help us live a normal life. We went to school, our brothers played football, we watched Bollywood films.

When civil war broke out in 1991, you and your family had to escape and eventually found asylum in Sweden. How did you do that?
We had to escape Somalia because of the war. We come originally from the north, and would have been targets for anti-north sentiments. We tried first to walk out of Mogadishu but we could not go far because we had our elderly grandmother in a wheelbarrow. However, after a few weeks, a distant relative put us on the top of an already packed lorry, and we hung on to the ropes that held the load together.

It was a dangerous journey, Militiamen wanted to rob the lorry and rape the women, and to avoid these dangers we drove where no roads existed. On several occasions the lorry nearly fell off the narrow mountain paths. My older sister was in Sweden and she arranged for us to join her.

You went on to study archaeology. What made you choose this subject?
The idea that the remains of past cultures could be excavated and history could be written based on this was very appealing. The recording of African history and heritage has been hampered and sometimes destroyed by slavery, colonialism, wars and pillaging. I wanted to be part of rescuing and writing about the rich heritage of Africa.

You have made some amazing archaeological discoveries in Somaliland, including 5000-year-old rock paintings. Tell me about them.
Dhambalin is a rock art site located in the desert 20 kilometres south-east of the coastal town of Berbera. The most striking element of the Dhambalin paintings is the images of sheep. This is the only site in the region that depicts sheep. It also depicts humans worshipping cattle with big udders, as well as hunting scenes, and some of the humans appear to be wearing headgear or masks.

What do the paintings tell us about life in the Horn of Africa several millennia ago?
The Dhambalin rock art site displays rich information about past symbolism and beliefs in the region. Many of the animals depicted - cattle, certain types of antelope and wild animals such as giraffes - no longer exist here due to climate change. Also the paintings show headless beasts with big udders, a symbol of fertility. These are similar to paintings found in north Africa.

What else have you discovered?
The recent discoveries include ruined early or medieval Islamic towns, burial sites with decorated upright stone monuments of pre-Islamic origin called steglia, and pre-Islamic Christian burial sites. The ruined towns tell us about ancient trade between the Horn of Africa and Arabia, India and China. We have found Chinese pottery from the Yuan and Ming dynasties, which is important since it brings the dating of the sites back to the 13th century. This helps us understand the period of seafaring and maritime interaction. We now have a list of potential World Heritage Sites.

What is your most important discovery?
If you mean material discovery it would be the Dhambalin rock art site and its depictions of sheep; it is one of a kind. But actually the most important discovery I have made is not a site or a material object, it's the notion of preserving knowledge and skill rather than objects - I call it the Knowledge-Centred Approach. It is a distinctive method amongst the Somalis for preserving heritage as knowledge rather than heritage as objects in museums and monuments. This perspective totally blew me away since it was completely different to what I had learned at university. I now use this methodology as a way of engaging local communities with material heritage such as objects and monuments.

Have you ever been threatened while you are out in the field?
Sometimes somebody may put obstacles in our way, but I have not been threatened personally. So far the danger has been due to landmines, snakes, car crashes and bad infrastructure such as non-existent roads.

What is it like to be the only working Somali archaeologist in the region?
It is a very daunting task. There is so much to be done because we are in a cultural emergency: our heritage is disappearing day by day. So being alone is not fun; I really need assistance. I feel I need to be in so many places at the same time.

It's also a humbling experience because, at the end of the day, I can only do my best to research and protect the heritage. I also feel that Somalis, although missing in the field of archaeology, appreciate the fact that

there is at least one person who is dedicated to saving this heritage. I receive many encouraging emails from people all over the world, both Somalis and non-Somalis, who support my work. That means a lot to me.

Why should archaeology be a priority when there are so many problems facing the Horn of Africa, including famine?
I see cultural heritage, including archaeological heritage, as a basic human right. Even people who are refugees or internally displaced need not only food and security but also a cultural heritage to understand their situation and to preserve their identity and dignity. Wars, poverty and droughts are dehumanising experiences which cultural activities and heritage awareness can protect against. And if we can protect and conserve cultural heritage, this helps create livelihoods through tourism and cultural resource entrepreneurship.

Why have you described the situation in Somalia as a "cultural heritage emergency"?
The intangible heritage relating to traditional practices such as Somali performance art, dances, songs and poetry, are all disappearing at an alarming rate due to the political conflict, displacement and older generations dying. But Somali tangible heritage is also disappearing due to the deliberate destruction of sites, looting and illicit trade of antiquities and unplanned development. Cultural heritage, both tangible and intangible heritage, is in an emergency situation.

Do you think that there are other archaeological sites yet to be discovered in this region?
Yes, there are many, probably over a thousand sites to be discovered. There are archaeological sites everywhere in the country; the region was a crossroads for many civilisations of the world. The region's arid climate has helped the preservation process. Also, most Somalis have until recently led a nomadic lifestyle and did not interfere with any of these sites, and there has been almost no farming or industrialisation. This is changing now, and there has recently been looting as the diaspora return and build factories and roads. There is an urgent need to document the heritage before it is too late.

Profile

Sada Mire is a fellow in the department of art and archaeology in the School of Oriental and African Studies, London. She is also heads the department of antiquities in Somaliland, an autonomous region of Somalia (see www.somaliheritage.org)

http://www.newscientist.com/article/mg21128240.400-somali-archaeologist-we-need-culture-in-a-time-of-war.html

Flooding of Ancient Salton Sea Linked to San Andreas Earthquakes

This map shows the current Salton Sea boundaries and outline of Lake Cahuilla at its peak size as well as locations of major area faults. (Credit: Scripps Institution of Oceanography, UC San Diego)

ScienceDaily (June 27, 2011) — Southern California's Salton Sea, once a large natural lake fed by the Colorado River, may play an important role in the earthquake cycle of the southern San Andreas Fault and may have triggered large earthquakes in the past.

Researchers at Scripps Institution of Oceanography, UC San Diego, the U.S. Geological Survey (USGS) and the University of Nevada, Reno, discovered new faults in the Salton Sea near the southern end of the San Andreas Fault. By examining displacement indicators preserved in pristine sedimentary deposits, the team reconstructed their earthquake history and found evidence for coincident timing between flooding of the ancient Salton Sea and fault rupture. Rupture on these newly discovered "stepover" faults has the potential to trigger large earthquakes on the southern San Andreas Fault.

The report appears in the online version of the journal *Nature Geoscience* on June 26.

The Salton Sea covers a structural boundary at the southern end of the San Andreas Fault where it takes a southwestward step to the Imperial Fault. The region is closely monitored because the last large earthquake on this section of the San Andreas occurred approximately 300 years ago and the fault is considered by many experts to be overdue for another.

By imaging beneath the Salton Sea, the study identified the key role of stepover faults that run at an angle to the San Andreas Fault. The smaller faults rupture relatively frequently and, at times, they ruptured in concert with Colorado River flooding of the Salton Trough. Report lead author Danny Brothers said that this research does not improve the ability to predict such a quake but suggests that heightened preparedness for a major quake immediately following smaller quakes in the stepover zone is warranted.

"To fully understand the hazards and rupture scenarios associated with the southern San Andreas Fault, we can't limit our study to the San Andreas Fault itself," said Brothers, a researcher now at the USGS who conducted most of the research while a graduate student at Scripps. "These stepover zones really need to be considered when assessing earthquake hazards and need to be examined as potential triggers for destructive earthquakes on the larger faults."

The current dimensions of the Salton Sea located in California's Imperial Valley are but a fraction of the natural lake that preceded it. Through cycles of flooding and evaporation, the historical Lake Cahuilla was once one and a half times the size of Lake Tahoe at its maximum. What is left since the beginning of the 20th Century -- when local authorities redirected the Colorado River away from the lake -- is less than 1/25th that size.

When its natural dimensions were in place, Lake Cahuilla and its surrounding region experienced in a 1,000-year period five earthquakes on the Southern San Andreas that are believed to have been larger than magnitude 7. The temblors occurred about 180 years apart. It's been more than 300 years since the last one. Diversion of the Colorado River and the lack of flooding events in the local basin known as the Salton Trough may be one possible explanation.

The researchers studied the sediments deposited over several millennia on the lake floor and found coincident timing between several flooding events and rupture of step-over faults, which in turn, may have loaded the San Andreas. Stress models showed that the predominantly normal faults with vertical displacement in the Salton Sea are more vulnerable to sudden increases in vertical loads caused by lake filling. Those failures may have triggered the movement of California's primary fault in several instances, the researchers said. No such sequence has taken place since the lake assumed its current dimensions.

"We've been baffled as to why the Southern San Andreas hasn't gone. It's been compared to a woman who is 15 months pregnant," said Scripps seismologist Debi Kilb, a report co-author. "Now this paper offers one explanation why."

The researchers cautioned that failure of the stepover faults is ultimately driven by tectonic forces and could still set off a major rupture of the San Andreas Fault independently of any lake level fluctuations. Other research teams have estimated that stress buildup in the area is still great enough to produce a quake between magnitude 7 and 8. The idea that the San Andreas is triggered by stress loading in the Salton Sea supports the assumption by many scientists that a future quake sequence could propagate northward and potentially cause significant damage in the Los Angeles area.

"Earthquake simulations reveal that shaking of large metropolitan areas such as Riverside and Los Angeles will be larger if the earthquake propagates from south to north -- our research suggests that the Salton Sea stepover zone may provide a trigger for such a propagation direction," said Scripps geologist Neal Driscoll, a report co-author.

Brothers said that one of the most immediate applications of the research is as a guide to development in the Salton Sea region, which has been the subject of environmental restoration efforts in recent years.

"Large earthquakes on the southern San Andreas most likely will be accompanied by liquefaction in the Imperial Valley. In addition to ground shaking, the liquefaction will cause damage to water conveyance systems and existing infrastructure in the region and is likely to affect Salton Sea restoration efforts," he said.

"Not only were we able to address seismic hazards issues along the San Andreas Fault, but this research also highlights the broader use and capabilities of new techniques and technologies to study hazards under bodies of water," added Graham Kent, director of the Nevada Seismological Laboratory at the University of Nevada, Reno and a co-author of the report. "This can have application for other regions where the presence of water has left problems undetected."

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - San Diego**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. John A. Hole. **Earthquake hazards: Rivers, rifts and ruptures**. *Nature Geoscience*, 2011; DOI: 10.1038/ngeo1198

http://www.sciencedaily.com/releases/2011/06/110627095757.htm

Archimedean molecule creates brand new compounds

- 17:26 22 July 2011 by **Melissae Fellet**

One of only 13 Archimedean solids, the truncated octahedron (Image: Scott Camazine/Alamy)

There are only 13 "Archimidean solids" - a family of symmetrical, 3D polyhedra attributed to the Greek mathematician. Now chemists have made a molecule-scale version of one of these special structures, known as the truncated octahedron (see picture, right).

The tiny, hollow structure acts as a cage, capable of encapsulating a surprising variety of ions and molecules without falling apart. It also aids the creation of substances that won't otherwise form.

Michael Ward of New York University, and colleagues, built their cage, which has eight hexagonal and six square faces, by blending two types of carefully-designed molecular "tiles", one made of chemical groups known as guanidiniums, the other ringed by sulfonate groups. These assembled into the truncated octahedron by forming 72 hydrogen bonds.

Stable cage

The negatively charged cage has encapsulated negative ions as well as positive ones, and neutral molecules. Usually a charged entity would only trap oppositely charged ions, says Ward.

By adding reactants to the tile mixture while the cages were forming, the team also created three metal "complexes" – containing bismuth, lead and mercury – that had never been seen before, inside the cages. The cages can be made to dissolve under mild conditions, so could be used to build and then release such substances. Often the contents of such a cage alters its structure. "But this particular system always finds its way to this same framework," says Ward.

"The result is fascinating," says Achim Müller of the University of Bielefeld in Germany. He is impressed that the team managed to create the truncated octahedron as it can be tough to predict the shape of such a structure ahead of time.

Journal reference: *Science*, DOI: 10.1126/science.1204369

http://www.newscientist.com/article/dn20727-archimedean-molecule-creates-brand-new-compounds.html

Brain Rhythm Associated With Learning Also Linked to Running Speed, Study Shows

Neurophysicists report that brain rhythms associated with learning become stronger as we move faster. (Credit: © Maridav / Fotolia)

ScienceDaily (June 27, 2011) — Rhythms in the brain that are associated with learning become stronger as the body moves faster, UCLA neurophysicists report in a new study.

The research team, led by professor Mayank Mehta, used specialized microelectrodes to monitor an electrical signal known as the gamma rhythm in the brains of mice. This signal is typically produced in a brain region called the hippocampus, which is critical for learning and memory, during periods of concentration and learning.

The researchers found that the strength of the gamma rhythm grew substantially as running speed increased, bringing scientists a step closer to understanding the brain functions essential for learning and navigation.

"The gamma rhythm is known to be controlled by attention and learning, but we find it is also governed by how fast you are running," said Mehta, an associate professor of physics and astronomy, neurology, and neurobiology and the senior author of the study. "This research provides an interesting link between the world of learning and the world of speed."

The study is published in *PLoS ONE*, a peer-reviewed online publication of the Public Library of Science.

The 'language of the brain'

How does the brain learn? The hippocampus is thought to rapidly and temporarily record facts and events as they are experienced, said Mehta, who also directs the Keck Center for Neurophysics at UCLA. During subsequent sleep, these temporary memories are thought to be consolidated to other brain regions for storage. If the hippocampus is damaged, it becomes very difficult to learn new things.

Understanding how the brain learns may one day help treat conditions such as Alzheimer's disease, dementia, and epilepsy that specifically target the hippocampus, Mehta said.

"Deciphering the language of the brain is one of the biggest challenges that human beings face," he said. "If we can learn to interpret these brain oscillations, it may be possible to successfully intervene in cases ranging from learning disorders to post-traumatic stress, or even to mitigate the effects of cognitive decline with aging."

The brain contains billions of neurons, specialized cells that transmit electrical and chemical signals. Neurons in the hippocampus encode spatial position information -- where one is in space -- through spikes, the sharp pulses that constitute the "syllables" of their language, Mehta said.
"You can imagine the brain as a large orchestra; the gamma rhythm is a continuously playing violin, punctuated by neuronal spikes similar to the beats of a drum" said Zhiping Chen, a fourth-year UCLA physics graduate student in Mehta's laboratory and lead author of the study.
The brain signals are a combination of multiple rhythms and neuron spikes from many different brain regions, each hinting at the language of the neurons, Mehta said. The challenge is to combine this vast amount of data to reveal the language of the brain and relate it to behavior.
"The biophysical laws that govern a single neuron are fairly well known," Mehta said. "What is not known is how those billions of neurons interact with one another and form the mind."
Tackling such interdisciplinary questions requires a diverse team of scientists and engineers. Members of Mehta's group have backgrounds in physics, mathematics, engineering, neurobiology, psychology and medicine, among other disciplines.
"We hope to explore the connection between psychology and neuroscience. Studying how the individual brain cells interact can explain how consciousness arises," said Chen.

The experiment

"The hippocampus is critical for navigation," Chen said. "Cells in the hippocampus encode position information, but to navigate, it is not enough to know where you are; you must also know how fast you are going. We concluded there must be a separate brain signal that encodes this speed information."
The experiment was performed by measuring electrical signals from hundreds of neurons using microwires 20 times thinner than a human hair, Mehta said. Nearly a hundred gigabytes of data was collected every day, enough to fill the Library of Congress every two months.
Analysis of this vast and complex data yielded an unexpected result: The gamma rhythm, a fast signal that occurs while concentrating or learning, gradually grew stronger as the mice moved faster.
"It is rare to find a relationship that is so clear," Chen said. "When we first saw the results, we were surprised and excited."
Does this mean movement or exercise could influence the learning process? Mehta said it is too early to tell.
"With these new results, we are asking questions which we never imagined," he said.
The study also verifies recent assertions that the gamma rhythm, which oscillates between 30 and 120 times every second, can be divided into slow and fast signals that originate from separate parts of the brain, Mehta said.
"Surprisingly, the two signals become increasingly separated in time with increasing speed," he said.
Additional co-authors of the study include Bert Sakmann, Nobel laureate and director of the Max Planck Florida Institute; Evgeny Resnik, a graduate student at the Max Planck Institute for Medical Research; and James McFarland, a postdoctoral researcher in the UCLA Department of Physics.
This research is funded by the National Science Foundation and the National Institute of Health, as well as the Whitehall Foundation and the W.M. Keck Foundation. Mehta and Chen are members of the newly established Integrative center for Learning and Memory at UCLA. Mehta is also a member of the Royal Norwegian Academy of Sciences.

From outer to inner space

Mehta began his career as a theoretical physicist interested in probing the nature of space-time. He was challenging long accepted ideas in the field before even finishing graduate school at the Indian Institute of Science.
Grappling with the mathematical complexities of universes with more than six dimensions, Mehta became fascinated by how learning occurs and what things the brain will absorb or learn most readily.
Mehta's previous research has shown that the hippocampal circuit rapidly evolves with learning and that brain rhythms are crucial for this process. The question now becomes: What is the relationship between activity in the hippocampus and behavior?
"It is amazing that we can understand things that are absolutely unnecessary for our survival," Mehta said.
"The brain is a very complex place, and our intuition about the mind is not enough to understand the brain. If we can first determine the rules of the brain, they will likely point in a direction that we have never imagined."

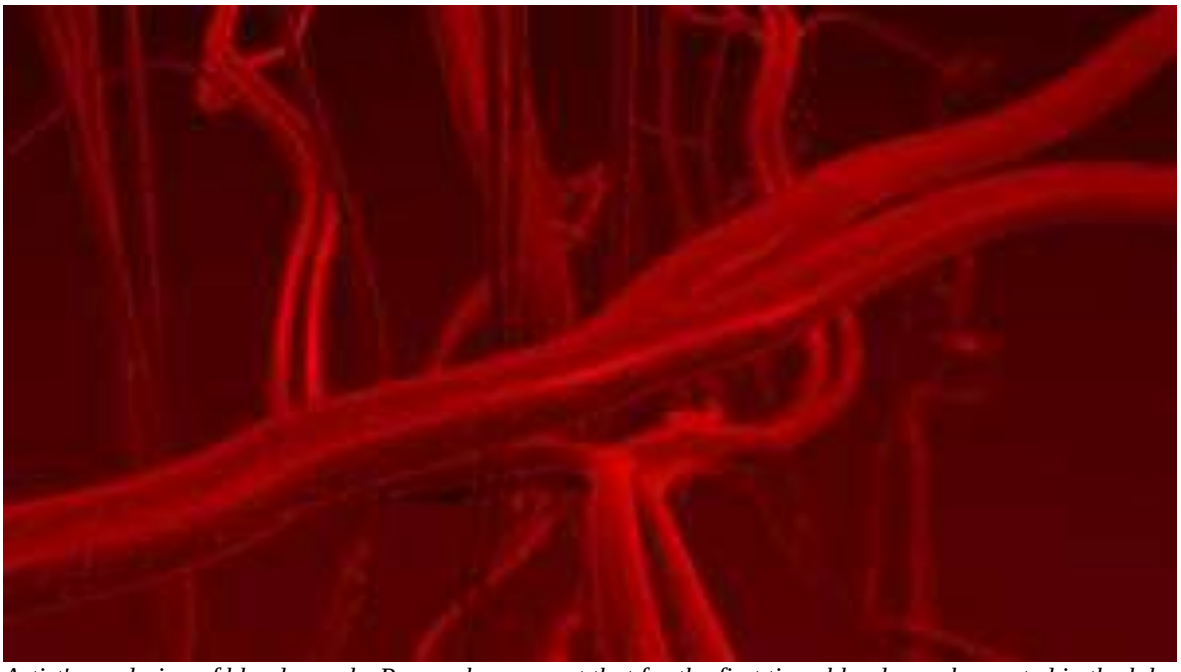
Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - Los Angeles**. The original article was written by Kim DeRose.

Journal Reference:

1. Zhiping Chen, Evgeny Resnik, James M. McFarland, Bert Sakmann, Mayank R. Mehta. **Speed Controls the Amplitude and Timing of the Hippocampal Gamma Rhythm**. *PLoS ONE*, 2011; 6 (6): e21408 DOI: 10.1371/journal.pone.0021408

http://www.sciencedaily.com/releases/2011/06/110627095832.htm

First Patients Receive Lab-Grown Blood Vessels from Donor Cells



Artist's rendering of blood vessels. Researchers report that for the first time, blood vessels created in the lab from donor skin cells were successfully implanted in patients. (Credit: © Dario Bajurin / Fotolia)

ScienceDaily (June 27, 2011) — For the first time, blood vessels created in the lab from donor skin cells were successfully implanted in patients. Functioning blood vessels that aren't rejected by the immune system could be used to make durable shunts for kidney dialysis, and potentially to improve treatment for children with heart defects and adults needing coronary or other bypass graft surgery.

For the first time, human blood vessels grown in a laboratory from donor skin cells have been successfully implanted into patients, according to new research presented in the American Heart Association's Emerging Science Series webinar.

While more testing is needed, such "off-the-shelf" blood vessels could soon be used to improve the process and affordability of kidney dialysis.

"Our approach could allow hundreds of thousands of patients to be treated from one master cell line," said study lead author Todd N. McAllister, Ph.D., co-founder and chief executive officer of Cytograft Tissue Engineering Inc., of Novato, Calif.

The grafts also have the potential to be used in lower limb bypass to route blood around diseased arteries, to repair congenital heart defects in pediatric patients and to fix damaged arteries in soldiers, who might otherwise lose a limb, said McAllister.

The tissue-engineered blood vessels, produced from sheets of cultured skin cells rolled around temporary support structures, were used to create access shunts between arteries and veins in the arm for kidney dialysis in three patients. These shunts, which connect an artery to a vein, provide access to the blood for dialysis. The engineered vessels were about a foot long with a diameter of 4.8 millimeters.

At follow-up exams up to eight months after implantation, none of the patients had developed an immune reaction to the implants, and the vessels withstood the high pressure and frequent needle punctures required for dialysis. Shunts created from patients' own vessels or synthetic materials are notoriously prone to failure. Investigators previously showed that using vessels individually created from a patient's own skin cells reduced the rate of shunt complications 2.4-fold over a 3-year period. The availability of off-the-shelf vessels could avoid the expense and months-long process involved in creating custom vessels for each patient, making the technique feasible for widespread use.

Besides addressing a costly and vexing problem in kidney dialysis, off-the-shelf blood vessels might someday be used instead of harvesting patients' own vessels for bypass surgery. A larger, randomized trial of the grafts

is under way for kidney dialysis, and human trials have been initiated to assess the safety and effectiveness of these grafts for lower-limb bypass.
The study will be presented in the American Heart Association's Emerging Science Series, which will be held at 1 p.m. EDT/ 12 p.m. CDT. The series is a free online webinar presentation of cutting-edge science. The Emerging Science Series provides a new venue for presenting the latest cardiovascular scientific breakthroughs several times a year, when the discoveries are ready to be presented rather than waiting for a regularly scheduled meeting. Each study is handled in a peer-reviewed process similar to late-breaking clinical trials presented at AHA's annual Scientific Sessions.
The series will include the first presentation of data from clinical trials, basic science, key updates of previously presented trials and major bench-to-bedside breakthroughs.
Co-authors are Wojciech Wystrychowski, M.D.; Lech Cierpka, M.D.; Krzysztof Zagalski, M.D.; Sergio A. Garrido, M.D.; Samuel Radochonski, B.S.; Nathalie Dusserre, Ph.D.; and Nicholas L'Heureux, Ph.D.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **American Heart Association**.

http://www.sciencedaily.com/releases/2011/06/110627134521.htm

How Humpback Whales Catch Prey With Bubble Nets

Humpback whales catch prey with bubble-net. (Credit: Image courtesy of Brill)

ScienceDaily (June 27, 2011) — Marine biologist David Wiley of the *National Oceanic and Atmospheric Administration* (*NOAA*) and others report in the latest issue of *Behaviour* how humpback whales in the Gulf of Maine catch prey with advanced water technology.

Humpback whales (*Megaptera novaeangliae*) are large baleen whales (up to 14 m long) that feed on a small prey in dense concentrations, such as krill or herrings. Humpbacks whales have large flukes relative to their size providing greater thrust for quick maneuvers. While other baleen whales feed by swimming rapidly forward, humpbacks are adapted for fine-scale movement to create bubble nets.

Behaviorally, humpback whales capture prey by engaging in complex feeding maneuvers that are often accompanied by the apparently directed use of air bubble clouds (the production of single or multiple bursts of seltzer-sized bubbles) to corral or herd fish. These whales create bubble nets to corral and contain planktonic prey into a small area so that they can more efficiently scoop them up in their large filter-feeding mouths. Based on surface observations, these bubble-feeding behaviors appear to vary in nature among both individuals and regions.

To learn more about how these whales use bubble nets in feeding, David Wiley and colleagues attached digital suction cup tags to whales that recorded depth and orientation in 3-D, allowing the scientists to recreate three dimensional images of whale swimming behavior and bubble release. The data revealed the release of bubbles while swimming in upward spirals and during a novel behavior called "double-loops" not previously known. Double-loops consist of one upward spiral to corral the prey, a smack of the fluke on the ocean surface (known as a "lobtail") then a second upward lunge to capture the corralled prey. This sequence of tools and targeting of prey seems as complex as the tool use of apes in the forest.

The study also reports that humpback whales work in teams of at least two individuals and are not beyond robbing the prey from the bubble nets set up by others.

Story Source:

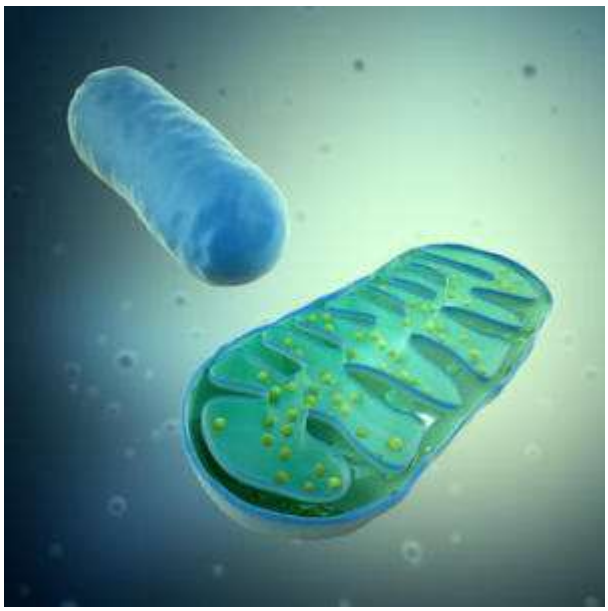
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Brill**, via AlphaGalileo.

Journal Reference:

1. David Wiley, Colin Ware, Alessandro Bocconcelli, Danielle Cholewiak, Ari Friedlaender, Michael Thompson, Mason Weinrich. **Underwater components of humpback whale bubble-net feeding behaviour**. *Behaviour*, 2011; 148 (5): 575 DOI: 10.1163/000579511X570893

http://www.sciencedaily.com/releases/2011/06/110624083516.htm

Premature Aging Caused by Some HIV Drugs, Study Shows



Artist's rendering of mitochondria, showing internal structure of one. DNA in mitochondria can be damaged by a class of antiretroviral drugs. (Credit: © Mopic / Fotolia)

ScienceDaily (June 27, 2011) — A class of anti-retroviral drugs commonly used to treat HIV, particularly in Africa and low income countries, can cause premature aging, according to research published June 26 in the journal *Nature Genetics*. The study shows that the drugs damage DNA in the patient's mitochondria -- the 'batteries' which power their cells.

The findings may explain why HIV-infected people treated with antiretroviral drugs sometimes show advanced signs of frailty and age-associated diseases such as cardiovascular disease and dementia at an early age.

Nucleoside analogue reverse-transcriptase inhibitors (NRTIs) -- of which the most well known is Zidovudine, also known as AZT -- were the first class of drug developed to treat HIV. They were a major breakthrough in the treatment of the disease, greatly extending lifespan and leading the condition to be seen as a chronic, rather than terminal, condition.

In high income countries, such as Europe and North America, the older NRTIs are used less commonly now due to concerns over toxicity and side-effects when taken over a long period of time. However, as they are now off-licence and hence relatively cheap, the drugs have proved to be an important lifeline for people infected with HIV in Africa and low income countries.

Professor Patrick Chinnery, a Wellcome Senior Fellow in Clinical Science from the Institute of Genetic Medicine at Newcastle University, says: "HIV clinics were seeing patients who had otherwise been successfully treated but who showed signs of being much older than their years. This was a real mystery. But colleagues recognised many similarities with patients affected by mitochondrial diseases -- conditions that affect energy production in our cells -- and referred them to our clinic."

Mitochondria are the 'batteries' in our cells which provide them with the energy to carry out their functions. During natural human aging, these mitochondria acquire mutations, though it is unclear whether these mutations are a cause of aging or a consequence.

In an attempt to understand what was happening at a cellular level, Professor Chinnery and colleagues studied muscle cells from HIV-infected adults, some of whom had previously been given NRTIs.

The researchers found that patients who had been treated with NRTIs -- even as long ago as a decade previously -- had damaged mitochondria which resembled that of a healthy aged person.

"The DNA in our mitochondria gets copied throughout our lifetimes and, as we age, naturally accumulates errors," explains Professor Chinnery. "We believe that these HIV drugs accelerate the rate at which these

errors build up. So over the space of, say, ten years, a person's mitochondrial DNA may have accumulated the same amount of errors as a person who has naturally aged twenty or thirty years. What is surprising, though, is that patients who came off the medication many years ago may still be vulnerable to these changes."
Co-author and HIV specialist, Dr Brendan Payne, a Medical Research Council fellow from the Department of Infection and Tropical Medicine at the Royal Victoria Infirmary, Newcastle, believes that despite the side effects caused by NRTIs, they are still important drugs and the risks are relative.
"These drugs may not be perfect, but we must remember that when they were introduced they gave people an extra ten or twenty years when they would otherwise have died," he says. "In Africa, where the HIV epidemic has hit hardest and where more expensive medications are not an option, they are an absolute necessity."
Professor Chinnery and colleagues are now looking at ways to repair or stall some of the damage caused by the medication and believe that focusing on exercise -- which appears to have a beneficial effect on patients with mitochondrial diseases -- may help.
The study was funded by the Medical Research Council, the British Infection Society, the Newcastle Healthcare Charity, the UK NIHR Biomedical Research Centre for Aging and Age-related Disease and the Wellcome Trust.

Story Source:
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Wellcome Trust**.

Journal Reference:

1. Brendan A I Payne, Ian J Wilson, Charlotte A Hateley, Rita Horvath, Mauro Santibanez-Koref, David C Samuels, D Ashley Price, Patrick F Chinnery. **Mitochondrial aging is accelerated by anti-retroviral therapy through the clonal expansion of mtDNA mutations**. *Nature Genetics*, 2011; DOI: 10.1038/ng.863

http://www.sciencedaily.com/releases/2011/06/110626145257.htm

Asteroid protoplanet may hold clues to Earth formation

- 13:52 28 June 2011 by **David Shiga**

A window ino the early solar system (Image: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA)

Never have old leftovers made so many scientists salivate. After a four year journey, NASA's Dawn spacecraft has returned the first close-up views of the giant asteroid Vesta, a relic of planet-building that could hold clues to how Earth formed.

At 530 kilometres across, Vesta is one of the biggest denizens of the asteroid belt, the junkyard of leftover planetary building blocks found between Mars and Jupiter.

For most of Dawn's journey, Vesta appeared as no more than a star-like speck in the sky. But Dawn is now close enough to return the best views of Vesta yet, surpassing the detail available in Hubble Space Telescope portraits.

Last week, NASA showed off the images to the media and described what Dawn will do to investigate Vesta while in orbit.

Early growth

"Vesta is a window into the early origins of our solar system and the terrestrial planets," said Dawn team member Carol Raymond of NASA's Jet Propulsion Laboratory in Pasadena, California. "We're on the edge of our seats waiting for this data to come in."

The pictures snapped by Dawn since mid-May are still blurry, showing only tantalising hints of craters on Vesta's surface.

But as the craft slips into orbit around Vesta in mid-July, cameras and spectrometers will reveal its topography and chemical composition. It's thought that Vesta finished growing long before Earth and the other planets, so might preserve clues to what that era of early planet formation was like.

After a year in orbit, Dawn will head to Ceres, the solar system's biggest asteroid. Unlike Vesta, Ceres seems to contain a lot of water-ice, and scientists hope data collected by Dawn will help them understand how the two large asteroids ended up so different in composition.

http://www.newscientist.com/article/dn20621-asteroid-protoplanet-may-hold-clues-to-earth-formation.html?full=true&print=true

Gender-spotting tool could have rumbled fake blogger

- 10:00 17 June 2011 by **Paul Marks**

Who's behind the blogs you read? (Image: Plainpicture)

Software that guesses a writer's gender could have prevented the world being duped into believing a blog that opposed the Syrian government and was striking out for gay rights was written by a young lesbian living in the country.

It turned out the author of the blog, "Gay Girl in Damascus", was a man – something the online gender checker would have picked up on. When *New Scientist* fed the text of the last blog post into the software, it said that the author was 63.2 per cent likely to be male.

Developed by Na Cheng and colleagues at the Stevens Institute of Technology in Hoboken, New Jersey, the ever-improving software could soon be revealing the gender of online writers – whether they are blogging, emailing, writing on Facebook or tweeting. The team say the software could help protect children from grooming by predators who conceal their gender online.

The fake blog highlights the problem of people masking their identity online. The truth about Amina Abdullah only emerged when the blogger disappeared, supposedly snatched by militiamen.

Online contacts realised that none of them had ever met Amina, and it turned out her blog photo had been stolen from a Facebook page. Then a 40-year-old American, Tom MacMaster living in Edinburgh, UK, confessed that he had been writing the blog all along.

Gender analysis

To determine the gender of a writer or blogger, Cheng and her colleagues Rajarathnam Chandramouli and Koduvayur Subbalakshmi wrote software that allows users to either upload a text file or paste in a paragraph of 50 words or more for gender analysis (update: since we posted this article, the servers have enjoyed more traffic than they can handle. If you can't get a response from clicking the links in this paragraph, we suggest trying again at a different time of day).

After a few moments, the program spits out a gender judgement: male, female or neutral. The neutral option points to how much of the text has been stripped of any indication of gender. This is something particularly prevalent in scientific texts, the researchers say.

To write their program, the team first turned to vast tranches of bylined text from a Reuters news archive and the massive email database of the bankrupt energy firm Enron. They trawled these documents for "psycho-linguistic" factors that had been identified by previous research groups, such as specific words and punctuation styles.

In total they found 545 of these factors, says Chandramouli, which they then honed down to 157 gender-significant ones. These included differences in punctuation style or paragraph lengths between men and women.

Other gender-significant factors included the use of words that indicate the mood or sentiment of the author and the degree to which they use "emotionally intensive adverbs and affective adjectives such as really, charming or lovely" which were used more often by women, says Chandramouli. Men were more likely to use the word "I", for example, whereas women used questions marks more often.

Bayesian algorithms

Finally, the software combined these cues using a Bayesian algorithm, which guesses gender based on the balance of probabilities suggested by the telltale factors. The work will appear in an upcoming edition of the journal *Digital Investigation*.

It doesn't always work, however. When the software is fed text, its judgement on a male or female writer is only accurate 85 per cent of the time – but that will improve as more people use it. That's because users get the chance to tell the system when it has guessed incorrectly, helping the algorithm learn. The next version will analyse tweets and Facebook updates.

Bernie Hogan, a specialist in social network technology at the Oxford Internet Institute in the UK, thinks there is a useful role for such technology. "Being able to provide some extra cues as to the gender of a writer is a good thing – it can only help."

Even a "neutral" decision might indicate that someone is trying to write in a gender voice that does not come naturally to them, he says. "It could be quite telling."

Testing the gender software

What did the gender identifier make of three well-known authors? We fed it some sample text to find out.

V. S. Naipaul, a winner of the Nobel prize for literature, claims he can tell a woman's writing by reading just two paragraphs of text, and controversially thinks female authors are no match for his writing. The software's verdict on this extract from his book *The Enigma of Arrival*: 88.4 per cent male.

Mary Evans was a female novelist who famously wrote under the male *nom de plume* George Eliot. The software has the measure of her, though. Its analysis of the writer's gender from the first paragraphs of *Middlemarch*: 94.6 per cent female.

More than 14,000 of Sarah Palin's emails were released by the state of Alaska last week after a lengthy campaign by various media organisations to obtain access to them. One email from the archive was put through the system, but the software got it wrong: 70.77 per cent male.

http://www.newscientist.com/article/dn20581-genderspotting-software-could-have-rumbled-fake-blogger.html

Dental robot flinches just like a real patient

12:15 30 June 2011
Robots
Mike Fitzpatrick, contributor

She blinks and flinches just like a real patient at the mercy of the dentist's drill.

And roboticists at Japan's Showa University say they have perfected their life-like dental training robot to such an degree they now feel she is ready to be let loose on her first dental students.

Revealed at a press conference in Japan yesterday "Showa Hanako 2" is a medical automaton capable of sneezing, head shaking, coughing, mimicking gagging, and will even close her mouth like a real patient when feeling that telltale jaw ache associated with the dentist reaching inside your mouth. With voice recognition technology the trainee dentist can even carry out a rudimentary conversation with the robot.

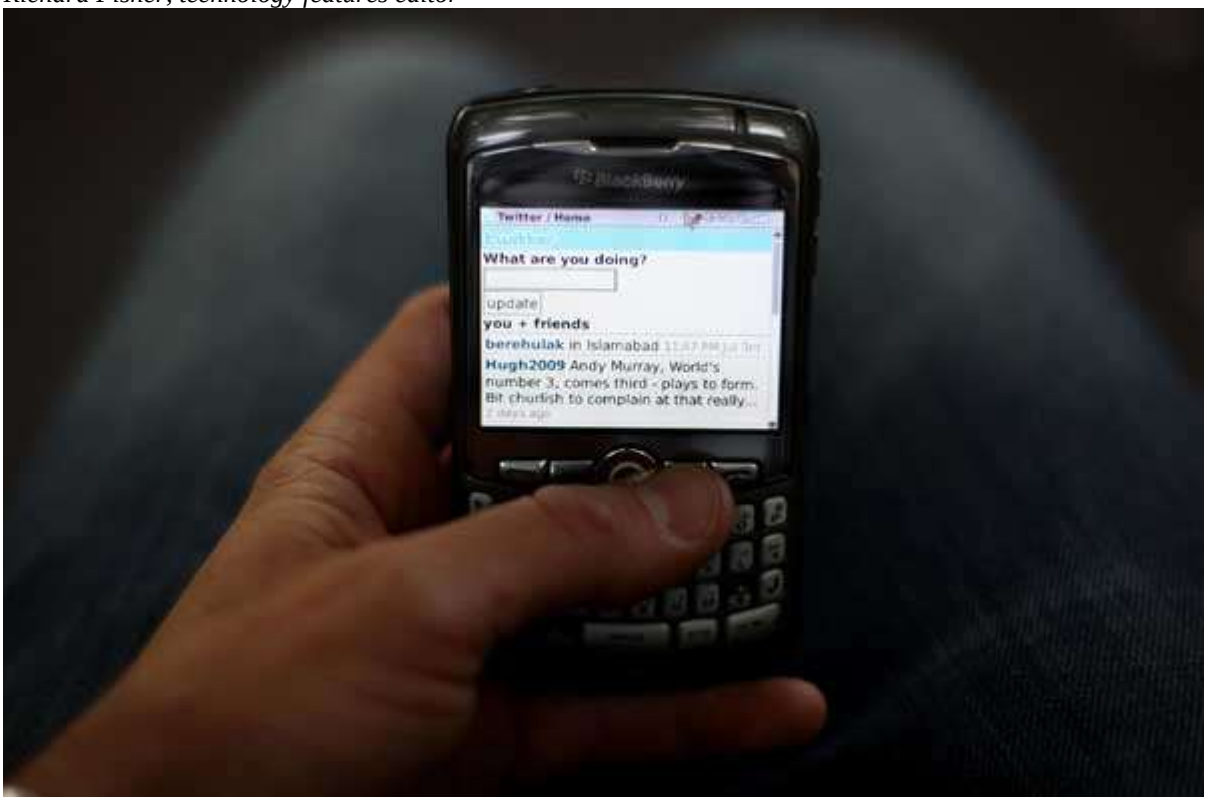
First developed by the team at Showa 10 years ago this first commercial model not only has more lifelike movements but her skin is quite possibly one of the more convincing aspects of her appearance, or of any robot to date. The creators enlisted the skills of Japan's top sex doll maker Orient Industry in the making of Showa Hanako's skin, tongue and mouth.

But Hanako's virtues are not only skin-deep. Once a check-up is complete the robot can store and analyse each student's performance giving feedback to any nervous novice through a computer link. Hanako will go on sale first in Japan later this year for an undisclosed sum.

http://www.newscientist.com/blogs/onepercent/2011/06/dental-robot-flinches-just-lik.html

A five-point guide to getting your tweets retweeted

11:25 29 June 2011
Twitter
Richard Fisher, technology features editor



(Image: Dan Kitwood/Getty)

What makes one tweet get passed on, and not another?

On Twitter, your followers can repeat your messages to their own followers. Getting such retweets is a way to increase your profile and network size, and it's arguably part of the reason why many users keep coming back: that little dopamine squirt you get when you discover somebody has liked your wittering can be addictive.

Retweeting is also one of the main ways that information spreads across the social network, so researchers, companies and governments want to know how it works. Previous research has shown that if your message is retweeted it will reach, on average, 1000 people, no matter how many followers you have.

Nasir Naveed and colleagues at the University of Koblenz-Landau in Germany wanted to find out how the specific content of a message can affect its probability of a retweet.

They studied a combined dataset of over 60 million tweets and around 4.5 million users, looking for the common conventions for retweets, such as the acronym "RT" or "via...". They then classified the content of the messages according to various factors, such as whether the tweets contained hyperlinks or emoticons, as well as analysing the language and types of sentiments expressed in the tweets. They presented their findings earlier this month at the International Conference on Web Science 2011 in Koblenz, Germany.

In general, tweets containing URLs, usernames, and hashtags - usually used to denote topics - were more likely to be retweeted than those without such paraphernalia. But not in isolation - other factors matter.

Naveed and colleagues identified five such rules to increase your chances of a retweet:

1) Watch your punctuation

Tweets with exclamation marks were unlikely to be retweeted. The opposite was true of question marks. The researchers speculate that in some cases this could be because tweets that pose questions are passed on to provide or find an answer.

2) Nice words trump nasty
Tweets containing strong positive words like "great" or "excellent" and negative terms such as "suck" or fail" were likely to be retweeted. But positive terms were slightly more so. The researchers suggest that this might be because people could be a bit more reluctant to retweet rude or harsh terms.
3) Use emoticons wisely
Conversely, including a positive emoticon, such as :-), is a sure way to lower your probability of a retweet. A negative one, such as :-(increases the chances.
4) Be relevant
The team identified more than 100 different topics that people tweeted about. Not surprisingly, those that addressed broader public interest were more likely to be retweeted than, for example, messages about how users felt that day, or messages directed specifically at another person (@replies). The most popular retweeted topics in the dataset concerned social networking, public holidays and the economy. The researchers reckon this suggests Twitter is better suited as a service for channelling news than for personal communication.
5) Bad news is good
The researchers studied the sentiments expressed in their dataset of tweets, by looking for words that are known to correspond to certain feelings. These were given a numerical value on various scales that range from, for example, pleasure to displeasure, or excitement to calmness. They found that tweets which were annoying or not pleasant tend to get retweeted often. Likewise for tweets that expressed exciting or intense sentiments. In other words, they say, bad news travels fast on Twitter.

http://www.newscientist.com/blogs/onepercent/2011/06/a-five-point-guide-to-getting.html

Autopiloted glider knows where to fly for a free ride

- 28 June 2011 by **MacGregor Campbell**
- Magazine issue 2818

Catching the thermals (Image: Danita Delmont/Gallo/Getty)

HAWKS and albatrosses soar for hours or even days without having to land. Soon robotic gliders could go one better, soaring on winds and thermals indefinitely. Cheap remote sensing for search and rescue would be possible with this technology, or it could be used to draw up detailed maps of a battlefield.

Glider pilots are old hands at using rising columns of heated air to gain altitude. In 2005 researchers at NASA's Dryden Flight Research Center in Edwards, California, flew a glider fitted with a custom autopilot unit 60 minutes longer than normal, just by catching and riding thermals. And in 2009 Dan Edwards, who now works at the US Naval Research Laboratory in Washington DC, kept a glider soaring autonomously for 5.3 hours this way.

Both projects relied on the glider to sense when it was in a thermal and then react to stay in the updraft. But thermals can be capricious, and tend to die out at night, making flights that last several days impossible, says Salah Sukkarieh of the Australian Centre for Field Robotics in Sydney. He is designing an autopilot system that maps and plans a glider's route so it can use a technique known as dynamic soaring when thermals are scarce. The glider first flies in a high-speed air current to gain momentum, then it turns into a region of slower winds, where the newly gained energy can be converted to lift. By cycling back and forth this way, the glider can gain either speed or altitude.

"Theoretically you can stay aloft indefinitely, just by hopping around and catching the winds," says Sukkarieh, who presented his research at a robotics conference in Shanghai, China, last month.

Inspired by albatrosses and frigate birds, the operators of radio-controlled gliders have used dynamic soaring to reach speeds of more than 600 kilometres per hour by flying between two regions of differing wind speeds. To plan a path for dynamic soaring you need a detailed map of the different winds around the glider. So Sukkarieh is working on ways to accurately measure and predict these winds. He recently tested his autopilot on a real glider, which made detailed wind-speed estimates as it flew.

The system has on-board sensors, including an accelerometer and altimeter, which measure changes in the aircraft's velocity and altitude to work out how the winds will affect the glider. From its built-in knowledge of how wind currents move, the system was able to work out the location, speed, and direction of nearby winds to create a local wind map.

By mapping wind and thermal energy sources this way and using a path-planning program, the glider autopilot should be able to calculate the most energy-efficient routes between any two points. The system would be able to plot a path up to a few kilometres away when the wind is calm but only over a few metres when turbulent, as the winds change so quickly, says Sukkarieh.

He says that the amount of energy available to a glider is usually enough to keep it aloft for as long as it can survive the structural wear and tear. He plans to test the mapping and route-planning systems more extensively in simulations, to be followed by actual soaring experiments.
"I think we have some examples from nature that mean this should be possible," says Edwards, who is not involved in Sukkarieh's research. "We're just taking our first baby steps into doing it autonomously."

Make like a hawk

Hawks and vultures are masters of spiralling upwards in rising thermals. But flying around in search of a free lift is not terribly efficient so Salah Sukkarieh of the Australian Centre for Field Robotics in Sydney thinks these birds have learned to recognise visual cues for thermals, such as towering cumulus clouds surrounded by blue sky. He's working on software that would allow a robotic glider to recognise useful cloud formations. By looking for wispy, or "smeared" clouds, the glider can find the horizontal winds that are good for dynamic soaring. At the same time, radar could measure the movement of airborne dust particles, giving an indication of wind speed and direction.

http://www.newscientist.com/article/mg21028185.700-autopiloted-glider-knows-where-to-fly-for-a-free-ride.html?full=true&print=true

Article analyser tells you what newspapers really think

- 14:44 28 June 2011 by **Jacob Aron**

"Raise taxes!" screams one headline. "Cut spending!" shouts another. With such conflicting views on offer, how is anyone supposed to make sense of the news? Perhaps a new tool can help – the software scans through news articles and identifies individuals or organisations that take opposing viewpoints on a particular issue, then maps out the relationships between disputing parties and identifies which side each article supports.
"The project aims to help readers to be aware of different views and have a more comprehensive understanding of news issues," explains Souneil Park, a computer scientist at the Korea Advanced Institute of Science and Technology in Daejeon, South Korea, who led the research.
Park's method identifies the disputing parties named in news articles by looking for both direct and indirect quotes. Direct quotes are simply those sentences contained within quote marks, while indirect quotes are indentified by looking for certain verbs such as "clarified" or "criticised", as in "the government clarified its tax policy but was criticised by the opposition".

Opposing parties

The software identifies both the speaker and the other parties they refer to and whether the words used are positive or negative, to determine their attitudes to others involved in the dispute. It then identifies the two key opponents in a debate and categorises the other parties according to their relationship with the main two.
For example, an analysis of articles about the 2010 Cheonan sinking incident, in which a South Korean naval ship was allegedly sunk by a North Korean submarine, places the North and South Korean governments as the key opponents, with other nations' governments mostly commenting on these two.
Park and team map out these relationships with an algorithm similar to Google's PageRank, which ranks the importance of websites based on incoming and outgoing links. Instead of looking at links, however, the software looks at the level of criticism one particular participant is both receiving and dishing out. The key opponents are those with the highest levels of criticism flowing in both directions.

For or against

With this relationship map in place, the researchers then classify articles according to whether or not they support the two key opponents. The classification depends on the number of quotes in the article, with articles being assigned to one side if the percentage of supporting quotes for that side reaches a certain threshold. Articles that don't meet this threshold are placed in a third, neutral category.
The team tested their software on 250 articles covering 14 contentious issues and found that it could correctly classify the two main sides of the argument in around 70 per cent of articles. The software failed to classify articles with few quotes, or articles that criticised someone while also frequently quoting them. Park says news aggregator sites like Google News could use his tool to provide readers with a balanced view on contentious issues, though the software is designed for use with Korean news articles and would need to be modified for English news or other languages. He presented the research at the Association for Computational Linguistics conference in Portland, Oregon last week.
Fabrice Florin, executive director of NewsTrust which aims to rate news articles for accuracy and fairness, says that the system could be useful though automated tools have their limitations. "You need a little bit of human intelligence in there," he explains. "We use a hybrid method that involves professional, amateurs and computers." He also points out that computers struggle to detect sarcasm or irony, making it hard to classify some quotes. "Sometimes we may say something that sounds negative, but if you read it more closely it's actually positive," he says.

http://www.newscientist.com/article/dn20622-article-analyser-tells-you-what-newspapers-really-think.html

Haptic soldiers guided by buzzing belt

- 27 June 2011 by **Duncan Graham-Rowe**
- Magazine issue 2818.

Pit your GPS away (Image: Teru Kuwayama/Corbis)

THE US army is testing a navigation device that allows soldiers to feel their way, literally, through the fog of war. The device, a haptic belt, feeds information to the wearer through coded vibrations and can also relay orders given as hand signals via a glove that recognises gestures.

Navigation can be extremely difficult for soldiers, especially at night, says Elmar Schmeisser, who has been leading the work at the Army Research Office in North Carolina. GPS devices are not ideal as they require soldiers to take their eyes off their surroundings and their hand off their weapon. The illuminated displays can give away their position at night, too.

So Schmeisser has spent the last few years working with different companies and research groups to find an alternative. He and his colleagues have now developed a range of vibrating mini electric motors known as tactile actuators, or "tactors", and tested them in various configurations. "What's best is a belt around the torso with eight tactors signifying the eight cardinal directions," says Linda Elliott, a psychologist who has been testing the systems on soldiers during training exercises at the Army Research Laboratory at Fort Benning in Georgia.

The tactors vibrate at 250 hertz, which is just enough to give a gentle but noticeable buzz around the torso at regular intervals indicating the direction in which the soldier needs to travel to reach the next waypoint.

The belts are hooked up to a regular GPS device to access directional information, as well as an accelerometer and digital compass. These mean the device knows which way the soldier is facing, even if they are lying down. "As long as you are going in the right direction you will feel it on your front," says Elliott, who will be presenting the technology at the Human-Computer Interaction conference in Orlando, Florida, in July. "As you get to within 50 metres of the waypoint all the tactors start to go off, and within 15 metres they will quicken."

Besides directions, the tactors can communicate commands such as "halt", signified by the front, back and side tactors pulsing simultaneously, or "move out", when they pulse from back to front, almost as if they were pushing the soldier forward.

While commands could be sent from base, Schmeisser and Elliott are also working with a company called AnthroTronix, which has developed a glove that has integrated accelerometers to detect hand gestures. The hope is to allow a platoon leader to be able to communicate with their squad while out in the field through standard military hand gestures sent wirelessly to their belts, says Elliott.

It's an interesting and useful development, says Katherine Kuchenbecker, director of the haptics group in the University of Pennsylvania's GRASP lab, in Philadelphia. Her group has previously made a haptic vest for

first-person shooter video games, where the tactors are activated to simulate a shot when the player is hit. "Conveying directional information through the skin is a nice complement to seeing and hearing one's surroundings," she says.

Elliott has tested the haptic belt on a number of different army personnel, from rangers to snipers, as they carried out six training exercises during the day and night. They were required to carry out various tasks, such as responding to requests for information and searching for targets, while navigating at the same time.

"We compared the performance with a handheld Garmin GPS and a traditional map and compass," says Elliott. Based on navigation time, errors en route and targets detected, the belt not only performed as well but the consensus among soldiers was that they loved it, because they didn't need to put down their weapon or take their eyes off their surroundings. As one soldier put it: "It is hands and thought-free."

http://www.newscientist.com/article/mg21028185.800-haptic-soldiers-guided-by-buzzing-belt.html?full=true&print=true

Trials kick off for long-range 'super' Wi-Fi
14:26 28 June 2011

Paul Marks, senior technology correspondent
There may be a gap in the market, the old adage goes, but is there a market in the gap? That's what Microsoft, BT, Samsung, Nokia and the BBC hope to find out in Cambridge, UK, over the next few weeks as they jointly test a wireless technology that's designed to exploit some of the most promising gaps on the planet: the unused "white spaces" between UHF digital TV frequencies.
They hope to show that these frequencies can be used to boost the range of wireless connections - offering a souped-up version of Wi-Fi that will keep laptops, smartphones and iPads online many hundreds of metres from our homes. The idea is that you switch on a white space router and it logs on to a database of the unused TV frequencies in your area. It then assigns your router a long-range UHF frequency you can use for a given time. It sounds easy - but there could be problems.
Technically, slotting a signal into a given waveband is not easy unless expensive filter circuits ensure transmissions stay strictly within assigned slots. If they don't, our supposedly pristine digital TV pictures could suffer interference. Yet expensive electronics will jack up white space device prices. Such are the issues the Cambridge TV White Space Consortium - which also includes white space pioneers Neul, Cambridge Consultants, Spectrum Bridge and TTP - will contend with in their trials which kick off tomorrow.
There may be a further problem brewing for this tech, however: over the last few months a quiet patent landgrab has taken place. For instance Sony, Nokia and Microsoft have filed for US patents on seemingly basic white space functions such as interference suppression, spectrum reservation and frequency assignment respectively. Hopefully the players in this field will pool their patents - as they did for MPEG-2 video - but if they don't we may well see a handful of tech majors cornering the white space router market.
Follow Paul Marks on Twitter: @paulmarks12

http://www.newscientist.com/blogs/onepercent/2011/06/white-space-patents.html

Deep sea gold rush: Mining hydrothermal vents

- 29 June 2011 by **Peter Aldhous**
- Magazine issue 2819.

Rich with minerals, hydrothermal vents could be mined with less damage than mining on land (Image: UK Natural Environment Research Council/Chesso Consortium)

As mining companies prepare to exploit the copper and gold in the seabed, we explore the fate of the unique ecosystems around tectonic boundaries

SOME 1600 metres below the waves, a 150-tonne tank-like vehicle wields a robotic arm armed with rotating rock cutters. After it has ground down the volcanic chimneys that rise from the sea floor, other mining robots follow in its tracks. One chews up the levelled seabed, composed of ores of copper and gold; another acts like a giant vacuum cleaner, gathering the finely ground rubble so that it can be pumped to a ship at the surface.

If all goes to plan, this is the scene that will play out in late 2013 at a site called Solwara 1, off the coast of Papua New Guinea (see interactive map). According to Nautilus Minerals of Vancouver, Canada, the company behind the scheme, the rich mineral deposits that form at marine hydrothermal vents - volcanic systems that spew scalding sulphurous water into the ocean - are the next frontier of mining. As well as exploiting other sites in Papua New Guinea's waters, the company intends to mine vents off Tonga, Fiji, Vanuatu and New Zealand.

The industry, if it takes off, is unlikely to be restricted to national exclusive economic zones - the regions that stretch up to 200 nautical miles (370 kilometres) seaward of each country's coast, over which it has rights to use the marine resources. Some of the biggest known hydrothermal vent fields, which cluster along tectonic plate boundaries, lie in international waters, and exploiting these fields is legally complicated. Next week, the Legal and Technical Commission of the International Seabed Authority (ISA), based in Kingston, Jamaica, will review applications from China and Russia for 15-year exploration contracts to begin prospecting at sites on the Southwest Indian ridge and the Mid-Atlantic ridge, respectively. The age of mining at hydrothermal vents, it seems, is dawning.

Vent fields are attractive for mining because they contain high-grade metal ores. Deposits at Solwara 1, for instance, are thought to contain 6.8 per cent by weight of copper, compared with about 0.6 per cent typically found at mines on land. The deposits form when water that has percolated through rock beneath the sea floor, dissolving sulphur and metals, is ejected at temperatures of up to 350 °C into the frigid deep ocean. Black metal sulphides precipitate out, forming vent chimneys. As chimneys topple and reform, vent fields can develop into mounds of metal-rich ore.

The prospect of mining these deposits alarms many scientists who study vents and their creatures. A variety of worms, molluscs and crustaceans inhabit the vents - including such oddities as 2-metre-long giant tube worms (*Riftia pachyptila*) and the yeti crab (*Kiwa hirsuta*), named for its "hairy" legs and claws. What makes these ecosystems remarkable is that the entire food web depends on microbes that get their energy by

oxidising hydrogen sulphide emitted from the vents - some of which live as symbionts inside larger organisms. This chemosynthesis is fundamentally different from the photosynthesis that sustains most life on Earth.

Since the first vents were seen in 1977, new animal species have been found at a rate of about one per month, with no sign of discovery rates falling off (see diagram). Given that vent ecology is still poorly understood, some researchers argue that it is too early to begin commercial exploitation. "We have really just scratched the surface of what lives in these areas," says Maurice Tivey, a vent scientist at the Woods Hole Oceanographic Institution in Massachusetts. "You have the potential of wiping out a community that you don't yet know exists."

That won't happen at Solwara 1, Nautilus officials insist. "The environmental impacts are going to be well managed," says Joe Dowling, the company's vice-president for communications. Indeed, Nautilus asserts that its activities at the relatively small Solwara 1, which spans just over 0.1 square kilometres - about the size of 10 football pitches - will be much less environmentally damaging than conventional mining, which typically occurs on a much larger scale.

Solwara 1 is a relatively quiet vent field that includes dormant chimneys and none of the gushing "black smokers" seen at the most spectacular vents. Still, chimneys venting hot water host vibrant populations of animals including *Ifremeria nautilei* snails and *Eochionelasmus ohtai* barnacles, which will be destroyed by mining. Nautilus is establishing a reserve site some 2.5 kilometres away, from which larvae should recolonise the mined area once operations cease, after 30 months or so. To minimise damage from mining spoil, particles larger than 8 micrometres across will be removed by the processing ship, before waste water is returned to the ocean, about 50 metres above the seabed.

As part of its evaluation, Nautilus commissioned independent scientists to survey both sites. They concluded that the reserve site was well chosen. "It is more diverse [than the area to be mined]," says marine ecologist Bob Kennedy of the National University of Ireland in Galway, a member of the team. "Mining may be an acceptable disturbance in the context of the natural variability and disturbed nature of these vent fields."

Samantha Smith, Nautilus's environmental manager, says the company will survey for recolonisation for at least three years after mining ceases and will monitor the effects of the fine sediment likely to fall on the seabed from the returning waste water.

Vent biologists contacted by *New Scientist* are generally impressed with Nautilus's environmental impact statement, but remain wary about the future if mining expands. "I'm concerned, and I'm paying attention," says Charles Fisher of Pennsylvania State University in University Park.

In March, the international body that coordinates vent science, InterRidge, sent the ISA a list of vent fields that it suggested should be considered for protection from prospecting. This included almost half of the 72 known active vent fields in international waters, and was based on a poll of vent scientists, some of whom wanted to protect all active sites. These are easier to find because of their "smoky" plumes.

Earlier this year, Cindy Lee Van Dover of Duke University's Marine Laboratory in Beaufort, North Carolina, who also worked on the site assessment for Nautilus, argued in *Nature* that mining and prospecting should be put on hold until firm guidelines for the conservation of vent ecosystems are in place (DOI: 10.1038/470031a).

That's unlikely to happen, but Adam Cook, a marine scientist with the ISA, says that the authority's legal and technical experts will issue environmental guidelines at a later date. He also points out that the prospecting that will be allowed under the ISA's exploration contracts is similar to the sampling already performed by vent researchers (see "Vent scientists clean up their act"). By the time mining takes off, if it does, guidelines should be in place.

For the foreseeable future, simple economics provides some reassurance that vents will not be trashed en masse. Perhaps 1 per cent of vent fields contain commercially viable mineral deposits, estimates Mark Hannington, an economic geologist at the University of Ottawa in Canada. But if prices of copper and gold rise, the incentives will shift.

The fear is that without strong oversight, subsequent environmental assessments may not be as rigorous as that conducted for Solwara 1. Vent fields differ radically in the species present and possibly the extent to which the animals at a particular site embody unique genetic diversity. "Every one of these developments needs an appropriate assessment," says Kennedy. "We shouldn't allow a Wild West free-for-all after one or two studies."

Vent scientists clean up their act

There's an irony to calls from marine researchers to restrict mining at hydrothermal vents: until now, the greatest threat to these natural wonders has been overenthusiastic scientific research.

The alarm was sounded in 1990 by Verena Tunnicliffe at the University of Victoria in British Columbia, Canada. She studied vent sites on the Juan de Fuca ridge in the north-east Pacific that had been visited by scientists at least three times in the 1980s. Populations of *Ridgeia piscesae* tube worms had plummeted at chimneys where sampling had taken place, but remained healthy at unsampled sites (*Journal of Geophysical Research*, DOI: 10.1029/JB095iB08p12961).

In some cases, even looking at vent animals can hurt them. In 1999, UK researchers found that the shrimp that congregate around vents on the Mid-Atlantic ridge had apparently been blinded by the powerful lights of submersibles that explored the vent fields (*Nature*, DOI: 10.1038/18142).

Fortunately, subsequent monitoring indicates that shrimp populations are doing fine, says Jon Copley of the University of Southampton, UK. But it was another reminder that scientists needed to put their house in order. "The last thing we want to do is damage them by studying them," Copley says.

Copley is co-chair of InterRidge, the international body set up to coordinate vent science, which in 2006 adopted a statement on responsible research. It calls on scientists to avoid any activities that will undermine the sustainability of vent organism populations, refrain from all but essential collections and avoid transplanting material or creatures between sites. It also asks researchers to share samples and information to avoid duplication.

But the statement lacks the teeth of an earlier draft code of conduct, put forward by Lyle Glowka, a consultant who today is a legal adviser to the UN Convention on Biological Diversity, and marine ecologist Kim Juniper of the University of Victoria. This would have asked national research agencies to make funding conditional on abiding by the code. "It fell flat on its face," says Glowka. "I think it was seen as a threat."

How closely scientists abide by the InterRidge statement is unclear. Earlier this year, Cindy Lee Van Dover of Duke University in North Carolina published a survey in which 90 per cent of researchers who responded said they followed the recommendations. However, half doubted whether their colleagues did - and only 5 per cent of more than 3000 scientists who were sent the questionnaire replied (*Conservation Biology*, DOI: 10.1111/j.1523-1739.2010.01642.x).

http://www.newscientist.com/article/mg21128193.700-deep-sea-gold-rush-mining-hydrothermal-vents.html?full=true&print=true

Aircraft punch 50-kilometre-wide holes in clouds

- 19:00 30 June 2011 by **Michael Marshall**

Hole-punched sky (Image: H. Raab)

Giant circular holes in clouds are caused by aircraft flying through. The planes create small holes a few tens of metres across, which can then expand to a width of tens of kilometres in a few hours.

Such holes have long been linked to aircraft, but until now no one could explain how they got so big. "It was a mystery," says Andy Heymsfield of the National Center for Atmospheric Research in Boulder, Colorado.

Heymsfield and his colleagues used a satellite called GOES to track 92 cloud holes over Texas over 4 hours in January 2007. The holes grew substantially within an hour, before slowly shrinking. The majority of the holes reached a diameter of between 10 and 50 kilometres.

It was clear how the holes got started. The clouds were supercooled, meaning their water was in liquid form despite being below 0 °C. Water can stay supercooled for a long time if left alone, but any disturbance turns it into ice. A plane flying through is more than enough to trigger freezing, at which point the resulting ice crystals fall away, leaving a hole. But that should only form a small hole.

Heat from ice

Heymsfield wondered if a side effect of making ice was causing the holes to grow. When liquid freezes it releases a little heat. This would cause the warmer air around the ice crystals to rise and the surrounding air to fall, starting a circulating current. As the falling air moved into a warmer zone its previously supercooled liquid water would evaporate.

The circulating air would carry this effect outwards, disrupting more of the cloud and triggering further evaporation. A cascade would be set off, causing the rapid expansion of the hole.

To test this idea, Heymsfield ran a detailed computer model of the internal workings of a cloud. He introduced a line of ice crystals such as that produced by an aircraft and watched as a hole grew to a diameter of 4.4 kilometres in 90 minutes.

Knock-on effects

But when he turned off the heating effect of making ice, the hole only grew slowly. If he also removed the effects of evaporation, the hole didn't grow at all.

It's a convincing explanation, says Raymond Shaw of Michigan Technological University in Houghton. "A little bit of ice totally changes the dynamics of the cloud," he says.

The holes could help to answer a long-standing puzzle: why some clouds produce rain but others don't. The key may be a few ice crystals, which "suck up" water from their surroundings and create droplets large enough to fall. The holes show that the process of crystal formation can have big knock-on effects, Shaw says.

Journal reference: Science, vol 333, p 77

http://www.newscientist.com/article/dn20642-aircraft-punch-50kilometrewide-holes-in-clouds.html?full=true&print=true

Economic benefits of shale-gas extraction unclear

- 30 June 2011
- Magazine issue 2819.

Is gas from shale viable? (Image: Steve Starr/Corbis)

TRAPPED gas could prove problematic for the energy industry. Despite the money being poured into efforts to extract natural gas from shale, the economic benefits are unclear.

Studies into shale gas extraction are typically supported by industry bodies. Because their reports are not peer-reviewed, economist Thomas Kinnaman of Bucknell University in Lewisburg, Pennsylvania, decided to review six of them himself. Three were written by academics at major universities, while three were written by private consultants. All support extracting shale gas, arguing that it creates new jobs and revenue.

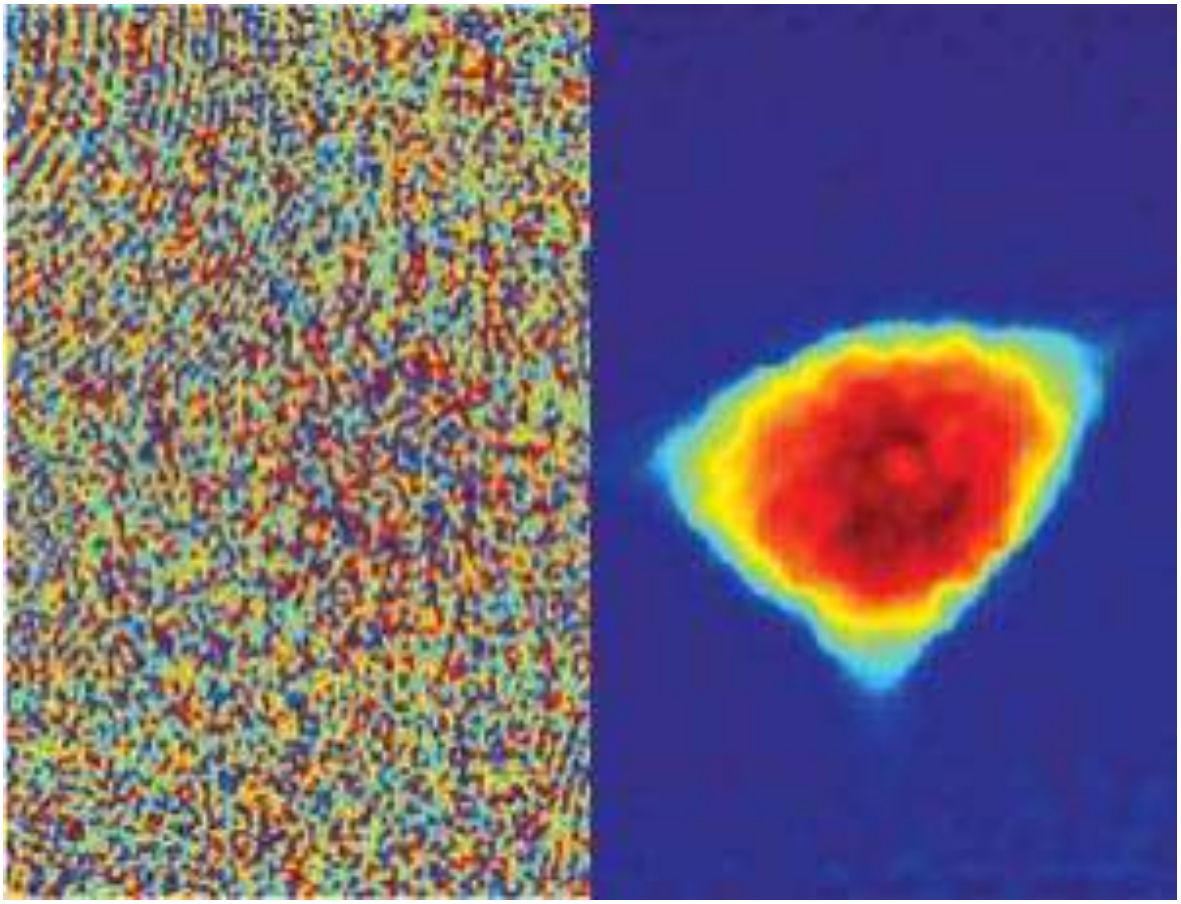
Kinnaman found that they all contained flaws that exaggerated the benefits of shale gas extraction to local economies. Most rely on an economic model called IMPLAN, which supposes, say, that local services such as hotel rooms are going unused until the gas industry comes along to spend money on them. In fact, such spending may displace other consumers, creating no net benefit. Kinnaman also claims that none of the studies measured all the costs and benefits of extracting shale gas, so could not determine if it really offers a net gain (*Ecological Economics*, DOI: 10.1016/j.ecolecon.2011.02.005).

This week *The New York Times* published hundreds of gas industry emails, many of which claim that the amount of gas being produced is exaggerated.

http://www.newscientist.com/article/mg21128193.400-economic-benefits-of-shalegas-extraction-unclear.html?full=true&print=true

Why skin is a better lens than glass

- 30 June 2011 by **MacGregor Campbell**
- Magazine issue 2819.



Looking through skin (Image: Wonshik Choi/Korea University)

IT'S as if Humpty Dumpty was put back together again - stronger than before. Light that passes through an opaque medium, such as an eggshell, can be reassembled in sharper detail and over a wider field of view than if it passed through a transparent lens alone. Such "scattering" lenses could one day be used to see individual living cells, replacing biopsies and improving surgical precision.

In 2007, Allard Mosk and colleagues at Twente University in Enschede, the Netherlands, demonstrated that materials not normally transparent to optical wavelengths can be used to sharply focus what little light gets through. By correlating input and output light, the researchers calculated a "transmission matrix" that defines how light is scattered by disordered particles in such a material. They used this matrix to design the shape of the incoming light waves so that they scattered off the particles and came to a focus on the other side.

In 2010, the researchers showed that such a lens could focus light into a spot one-tenth the size of that produced by an ideal transparent lens of the same size, making the focus 10 times as sharp. In May, they imaged gold nanoparticles at a resolution of just 97 nanometres, to show that scattering lenses can image below the 200-nanometre limit of conventional optical lenses (*Physical Review Letters*, DOI: 10.1103/PhysRevLett.106.193905).

It is a painstaking process, though. To create an image with such high resolution, they had to take "zoomed in" snapshots of small regions of the nanoparticles and then stitch these images together. The technique

"achieves a sub-100-nanometre resolution that puts a smile on our faces every day", says Mosk. "But it does so at a cost of being rather slow and having a very small field of view of only a few micrometres."
Now Wonshik Choi of Korea University in Seoul and colleagues have found a way to take pictures that are a thousand times as wide - up to several millimetres, though the resolution is lower than with Mosk's method. Their technique, detailed in a paper to appear in *Physical Review Letters*, measures the transmission matrix of a potential lens faster and in more detail than previous methods.
They used a 450-micrometre-thick slice of fresh rat skin as a lens. First they illuminated it from different angles, capturing around 20,000 images of the resulting transmitted light in 40 seconds. This provided a detailed 3D model of the skin sample's transmission matrix.
Then they placed a microglial cell from a rat's brain behind the skin-lens and took another image (see left image). They used pattern-matching software to sort through the 20,000 images to determine which regions of the matrix were in front of the cell. This allowed them to piece together a detailed picture of the cell (right image).
The technique provided a field of view five times as wide as a traditional lens. This is because rays of light reflected from the target at angles too wide to be intersected by normal lenses are bent into a detector by the scattering lens (see diagram). "Our system can perform wide-field imaging by converting a distorted image into a clean image using the recorded transmission matrix," says Choi.
"It is very nice work," says Jochen Aulbach at the FOM Institute for Atomic and Molecular Physics in Amsterdam, the Netherlands. "It brings the concept of scattering lenses a big step closer to application for wide-area microscopy."
"I know of no other compact optical system that combines such high resolution with a field of view that large," says Mosk. He hopes to see a hybrid system that combines his resolution with Choi's speed and field of view. Ultimately, he says, the technique could improve surgeons' views of what to cut during keyhole surgery. "Light scattering may seem detrimental to imaging, but in fact a scattering system can make an almost perfect lens."

http://www.newscientist.com/article/mg21128193.800-why-skin-is-a-better-lens-than-glass.html?full=true&print=true

Irradiating organic food would save lives

- 28 June 2011 by **Dominic Dyer**
- Magazine issue 2818.

Time to adopt technologies that may save lives (Image: Mark Langridge/Mood Board/Rex Features)

Organic farming must ditch its irrational mistrust of science or risk losing its reputation as being safer and healthier

I WORKED closely with the organic industry for almost a decade, first as head of the UK Food and Drink Federation's Organic Food Manufacturers Group and then as a representative on the UK government's Organic Action Plan Committee. I believe that the growth in the organic food sector has brought many benefits to farmers, food producers and consumers around the world.

The market for organic food has developed rapidly over the past 20 years as more consumers have become willing to pay a premium for products they consider to be both healthier and better for the environment. Although the recent economic downturn has led to a significant reduction in organic food sales, there are now over 170,000 organic farms in Europe, covering almost 2 per cent of the total agricultural land.

The organic industry can be proud of its achievements in putting animal welfare, environmental protection, traceability and food quality at the heart of the farming and food agenda.

However, in recent years I have become increasingly concerned by the willingness of the organic industry to market its products as both a healthier and safer alternative to conventional food production. They are not. In fact, by shunning science, organic producers could be increasing consumers' risk of contracting *Escherichia coli* and other food-borne diseases.

The recent fatal *E. coli* outbreak centred on Germany has focused attention on the validity of the claims that organic food is healthier and safer. The outbreak has been traced to bean sprouts grown on an organic farm in Bienenbüttel, northern Germany. As *New Scientist* went to press, 35 people had died in the outbreak and thousands more were made ill. As a result, concern is growing over standards of microbiological food safety in organic farming.

So are we at higher risk of *E. coli* and other food-borne diseases from organic food and, if so, what can producers do to reduce this risk and restore confidence in the organic brand?
There have been very few scientific studies comparing the microbiological safety of organic and conventional food production systems. In theory, organic food could be more prone to microbial contamination due to the absence of preservatives and the use of manure as fertiliser. However, where studies have been carried out, the results have not been conclusive. This is due to a number of factors, including a small sample size and a failure to factor in seasonal and regional variations.
What is clear is that both organic and conventional foods are susceptible to contamination by pathogenic microorganisms at every point in the food chain. It can occur during production, from manure and water, during processing from environmental sources and during the final handling and packing, possibly as a result of poor human sanitation.
One area where organic production systems might pose a higher health risk is through the use of untreated manure as fertiliser. Studies carried out on organic and conventional produce by Minnesota farmers in 2004 found that *E. coli* contamination was 19 times greater on organic farms which used manure or compost less than 12 months old than on farms which used older materials.
Although the risks are reduced as manure matures, researchers have found that many pathogenic organisms such as *E. coli* and salmonella can easily survive up to 60 days or more in compost and in the soil, depending on temperature and the condition of the soil.
Another extra risk factor in organic production is the avoidance of fungicides, which can lead to the growth of moulds and increased risk of mycotoxins such as aflatoxin and ergot in crops.
Taking these risks into account, and with recent events in Germany in mind, I think organic food producers need to focus on risk management. More research should also be done into pathogen survival in the food chain.
I also believe that the organic industry must put aside its suspicion and mistrust of science in food production and look at how it can introduce new systems that reduce the risk of future outbreaks of deadly food-borne diseases such as *E. coli*.
The real tragedy of the *E. coli* incident in Germany is that the outbreak could have been prevented if the organic industry had been willing to irradiate their produce. The bean sprout crop that was the source of the outbreak requires a warm and humid environment to grow, which increases the risk of contamination by *E. coli* and other disease-causing bacteria. The only certain means of reducing this risk is to irradiate the bean sprout seeds, which effectively kills 99.999 per cent of *E. coli*. There is no evidence that food irradiation is harmful to consumers, and also no evidence that it affects the nutritional quality of food.
Despite these facts, the organic industry continues to lobby against the use of irradiation. When President Bill Clinton's agriculture secretary Dan Glickman proposed including irradiation in the US National Organic Standards in 1998 - specifically to reduce *E. coli* risk - the US Department of Agriculture received over 300,000 petitions from individuals and organisations in the US and Europe opposing this move. As a result this provision was removed from the final legislation.
If the organic industry is to retain confidence it must show that it is willing to adopt technologies which put food safety first. If organic food is irradiated then the technology will be more widely accepted across the food chain in general and lives will be saved. That is a goal every food producer should be striving for.
Dominic Dyer *is chief executive of the UK Crop Protection Association based in Peterborough and has many years experience working with the organic food industry*

http://www.newscientist.com/article/mg21028186.200-irradiating-organic-food-would-save-lives.html?full=true&print=true

Rabies may not be the invincible killer we thought

- 16:48 21 June 2011 by **Ferris Jabr**

Precious Reynolds: would she have survived without the Milwaukee protocol? (Image: Renãe C. Byer/Sacramento Bee/Landov/PA)

Earlier this month, 8-year-old Precious Reynolds of California became only the sixth person known to survive rabies without receiving a vaccine shortly after infection. At the University of California Davis Children's Hospital doctors treated Reynolds with the Milwaukee protocol – an experimental procedure that plunges the patient into a drug-induced coma, taking the brain "offline" while the immune system scours the virus from infected neurons.

But the Milwaukee protocol is not a miracle cure for rabies – far from it. Since Rodney Willoughby of the Children's Hospital of Wisconsin in Milwaukee developed the treatment in 2004, the protocol has been tried at least 35 times around the world in attempts to save people with rabies. Including Reynolds, only five have ostensibly benefited from the treatment.

Why has the Milwaukee protocol worked in only a few cases? The answer may be that the survivors owe their lives not to the experimental treatment, but to a combination of fortunate circumstances and a robust response from their own immune systems.

New research suggests that rabies is not quite the unequivocally fatal disease we think it is. The six known survivors may have been infected with weak strains of the rabies virus that their immune systems were able to eventually scrub from their brains – with or without the Milwaukee protocol.

Beware bats

On 12 September 2004, 15-year-old Jeanna Giese scooped up a bat from the floor of St Patrick's Church in her hometown of Fond du Lac, Wisconsin. As she left the church, the bat bit her finger. Thirty-seven days later, Giese entered St Agnes Hospital in Fon du Lac with a fever, double vision and a twitchy arm. When her mother mentioned the bat to the doctors they diagnosed Giese with rabies and referred her to Willoughby.

If someone receives a series of vaccines within a few days of being bitten by a rabid animal they almost always survive rabies. But once the virus has spent a few weeks travelling through the peripheral nervous system to the brain – and serious symptoms like paralysis, insomnia and foaming at the mouth appear – death soon follows.

Determined to treat Giese, Willoughby searched the research literature and noticed that autopsies of people with rabies showed no signs of brain damage. This, he reasoned, meant the virus was not exploding nerve cells – it was subtly interfering with neurochemical communication, disrupting how the brainstem regulates heart rate and breathing. If he could use drugs like ketamine and midazolam to induce a coma – muffling the brain so it evades the chemical curse of the rabies virus – he might be able to buy the immune system enough

time to clear the infection. It worked. Giese recovered, although she still has some slight speech and motor problems.

Weak vaccine

On 6 March 2009, a 17-year-old girl entered a community hospital in Texas with a severe headache, rash and weakness in the limbs. Her doctors diagnosed her with encephalitis and administered antiviral and antibacterial drugs. When the girl mentioned contact with bats two months earlier during a hiking trip, the doctors tested her for rabies and found antibodies against the virus in her blood. They gave her single doses of rabies vaccine and human rabies immune globulin (HRIG) instead of the full dose, fearing she might develop too strong an immune response and damage her brain. Even without intensive care and the Milwaukee protocol, the girl recovered swiftly and was discharged.

The recent case of Precious Reynolds shares important characteristics with the 2004 and 2009 incidents. Firstly, none of the three girls was infected by a dog – Reynolds was most likely bitten or scratched by a feral cat. Different animals host different strains of the virus and the dog virus has always been the most fatal to humans worldwide. Secondly, none of the girls tested positive for the virus itself, only for antibodies to it, which suggests their immune systems had already mounted a defence and cleared most of what was likely a weaker strain of the virus.

In all three cases it is possible that the human immune system – with or without the Milwaukee protocol – vanquished a weak strain of the rabies virus. Researchers have known for years that some animals in the wild and in the lab survive rabies all on their own. New research points to the blood-brain barrier as "the arbiter of life and death" in a case of rabies, as D. Craig Hooper at Thomas Jefferson University in Philadelphia, Pennsylvania, puts it.

Hooper and his colleague Bernhard Dietzschold have pioneered research on how the blood-brain barrier permits immune cells to attack the rabies virus in the brains of mice. "The dogma has always been that when the rabies virus reaches the brain there is no hope for recovery," says Dietzschold. "We have shown in animal models that this is not right – the immune system can clear the virus from the central nervous system."

Cloaked viruses

Hooper and Dietzschold have discovered that the immune system responds quite differently to virulent and weaker strains of the rabies virus. The virulent strains are more cunning, effectively cloaking themselves from the immune system until it is too late. But weaker strains give themselves away to the immune system more quickly – perhaps because they have more glycoproteins, tiny surface molecules to which antibodies bind. If the immune system detects a weak rabies virus early enough, it grants immune B and T cells access to the brain.

When Hooper and Dietzschold gave mice that already had rabies a weakened but live form of the rabies virus, they found that the mice cleared the infection on their own. All current rabies vaccines for people – both preventative and post-infection – use tiny bits of dead virus that do not clear viruses from the central nervous system, says Hooper. A weakened live version of the rabies virus could be a future alternative to the Milwaukee protocol for people who do not realise they have rabies until it's almost too late.

The work also rewrites the story of rabies as an unbeatable killer. "Are there people out there who have had rabies and recovered without signs at all?" wonders Hooper. "We look at rabies as a lethal disease when it appears there are exceptions."

http://www.newscientist.com/article/dn20593-rabies-may-not-be-the-invincible-killer-we-thought.html?full=true&print=true

Men's health expert: Why being male is bad for you

- 21 June 2011 by **Jessica Griggs**
- Magazine issue 2817

Alan White is professor of men's health at Leeds Metropolitan University, UK

*There are huge disparities between the health of men and women says **Alan White**, who wants to turn this gender bias around*

Does gender make a difference when it comes to health?

Yes. There are huge disparities. Around 630,000 men die between the ages of 15 and 64 in Europe, compared with 300,000 women in the same age group. We have looked at data from across Europe and found that men die prematurely from nearly every condition that should affect men and women equally: heart disease, cancer, pneumonia, type 2 diabetes. The list goes on. The trends are the same in the US too.

Why are men so much more unhealthy than women?

There are an awful lot of reasons. Men's lifestyle is problematic: they smoke and drink more than women, and eat less healthily. And how men respond to worsening social conditions and unemployment is a major factor. For example, they are more likely to commit suicide.

Isn't it simply a biological fact that women live longer than men?

I think it is because people make this assumption that no one has really stood back and questioned why so many young men die. It is not inevitable. Yes, there are some physiological reasons why men are more vulnerable to certain diseases, but we have found such massive differences in the health of men compared with women across Europe, that we have to recognise that the vast majority of premature deaths in men can be prevented.

You think that we should look at men and women differently when it comes to health, but surely an illness is an illness?

When we are ill, how we respond is greatly influenced by our gender. From birth there are different socialisation processes at play that influence how boys and girls grow up. This affects risk-taking, knowledge of food and health, perceptions of weight, mental and sexual health. The way men and women use health

services, the way health services treat us, working practices... all are gender-biased and have a great influence on the way we manage our health and well-being.
The higher male death rates for diseases that should affect men and women equally means that no disease should be considered gender neutral.

What can be done to turn this around?

Take mental health. We need to reach out to men in a different way. When men find things difficult they often retreat, get more irritable, smoke and drink more. They don't see this as a sign of mental health issues. They see it as just being "male".
We also need to set up services that men can actually use. In Europe, men are more likely to be unavailable during the times most health clinics operate. We need more initiatives like the one in the UK run by Newcastle United football club, which puts on badminton classes at midnight for taxi-drivers and restaurant workers.

Are you a good example of a healthy man?

I try to keep my weight down, and I don't smoke or drink much, which makes a big difference. But don't look at me for a healthy work-life balance - I am a workaholic.

Profile

Alan White is professor of men's health at Leeds Metropolitan University, UK, and lead author of *The State of Men's Health in Europe*, published in July. See a summary at bit.ly/9pK1jt

http://www.newscientist.com/article/mg21028176.100-mens-health-expert-why-being-male-is-bad-for-you.html?full=true&print=true

Family ties doubted in Stone Age farmers

- 15:57 01 July 2011 by **Michael Marshall**

The exposed foundation walls of Çatalhöyük (Image: Interfoto/Alamy)

Blood may not always be thicker than water, if a controversial finding from one of the world's best-preserved Stone Age settlements is to be believed. At Çatalhöyük in Turkey, it appears that people did not live in families. Instead, the society seems to have been organised completely differently.

Discovered in 1958, Çatalhöyük's many buildings are built so close together that people had to get in through the roof. Its inhabitants farmed crops and domesticated animals, and experimented with painting and sculpture.

They also buried their dead beneath the floors of the houses, suggesting that people were buried where they lived. So Marin Pilloud of the Central Identification Laboratory in Hickam, Hawaii, realised she could work out who lived together.

With Clark Spencer Larsen of Ohio State University in Columbus, Pilloud took detailed measurements of the teeth from 266 skeletons. Closely related individuals have more similar teeth than unrelated individuals, so she could get a measure of how related the remains were.

No nuclear

Because Çatalhöyük is made up solely of small houses, Pilloud expected it to be organised rather like a modern village, with "small nuclear families living together and defining the community", she says. So people buried together should have been more closely related than people from different houses.

But she found no pattern at all. "It does not appear that individuals that were buried together were closely related to each other," she says. "Çatalhöyük was likely not centred around nuclear families."

More recent burial sites have tended to show strong familial patterns, but no other Stone Age site has been analysed in this way, so there's no way to know if Çatalhöyük is typical of the time.

We are used to the idea that living in close contact with our relatives helps to promote our own genetic inheritance and keep hold of our money and possessions over the generations. So why should Stone Age populations be different?

Coming and going

Pilloud thinks Çatalhöyük developed its odd social structure as the people began settling down and farming, rather than hunting and gathering. "It makes a lot of sense to shift to a community-centred society with the adoption of agriculture," she says. People living in close quarters all year round and working together to produce food needed to create a strong community, rather than only cooperating with relatives.

Another explanation might be that earlier hunter-gatherer societies were also less family-centric than we thought. Kim Hill, of Arizona State University in Tempe has found that modern hunter-gatherer societies are extremely fluid, with both males and females regularly leaving the group they were born in. That means many individuals within each group are completely unrelated (*Science*, vol 331, p 1286).

Çatalhöyük society looks remarkably similar, Hill says. "This might imply that such patterns are ancient, common, and persisted even in the early transition from foraging to farming."

Family genes

It would have been better to use DNA samples to look for kinship, says Colin Renfrew, of the University of Cambridge. "I have always been rather unimpressed by dental data as indicating biological kinship."

However, Çatalhöyük's warm climate may have long since destroyed the skeletons' DNA, Renfrew adds. DNA has been recovered from German Stone Age farmers, but in that case researchers did not attempt to discern their social structure (*PLoS Biology*, DOI: 10.1371/journal.pbio.1000536).

Although DNA analysis would be ideal, the research is nevertheless "quite pioneering", says Roger Matthews of the University of Reading in the UK. "It adds to the already strong evidence that biological kinship need not have had much significance in early prehistoric societies."

Journal reference: *American Journal of Physical Anthropology*, DOI: 10.1002/ajpa.21520

http://www.newscientist.com/article/dn20646-family-ties-doubted-in-stone-age-farmers.html?full=true&print=true

Sleeping babies can hear you're upset

- 17:00 30 June 2011 by **Jessica Hamzelou**

An MRI scanner - not your everyday location for a nap (Image: Michael Crabtree)

Parents, beware waiting until your baby nods off before arguing over the housework – the sleeping infant will still be listening in.

Declan Murphy and his colleagues at King's College London used a functional MRI scanner to watch how babies' brains responded to sounds while they slept. The group used a modified scanner quiet enough to scan 21 infants aged between 3 and 7 months without waking them.

Murphy's team first compared the babies' responses to human non-verbal vocalisations – such as coughs and sneezes – and other sounds that the tots would be familiar with, like the sounds produced by a musical toy. They found that different regions of the babies' brains responded more strongly to the different stimuli in the same way that an adults' awake brain does.

The group then played the sleeping infants sad, neutral and happy human vocalisations, which included the sounds of crying and laughter. In all cases the scans revealed significant activity in several brain regions including the middle temporal gyri, right lingual gyrus and medial frontal gyri – such patterns of activity are seen when adults who are awake listen to such sounds.

While the babies' brains responded in a similar way to both happy and neutral sounds, sad sounds – such as the sound of crying – resulted in stronger activation in regions of the brain called the insular cortex and gyrus rectus. This pattern of activity is also seen when adults who are awake hear sad sounds.

Don't panic

"It's fascinating that they can do this," Murphy says. "You'd think that a sleeping baby wouldn't be able to hear you, but clearly their brains are processing sounds while they're asleep."

The finding might send a chill down the spine of all parents that have engaged in a whispered argument over a sleeping child, but Murphy points out negative sounds might not necessarily be detrimental for the baby. "It could be a good thing – the brain could be training itself to respond to these sounds," he says.

The reason why sleeping babies tune in to the sounds around them remains a mystery. "It could be because they are hard-wired to be alert," Murphy suggests. Emanuel DiCicco-Bloom, who researches child neurology at Robert Wood Johnson Medical School in Piscataway, New Jersey, agrees. "This might mean that certain brain regions needed for survival are already specialised very early, and are less dependent on extensive postnatal experience," he says, adding that babies may even learn to distinguish such sounds through eavesdropping on the outside world while still in the womb.

Early warning

Murphy hopes his continuing research will provide insight into social communication, and how problems in processing emotional speech develop in autism. "If we're going to understand how people develop abnormal processes, we need to understand normal development."

The team has begun to look at the brains of young infants with older autistic siblings. Such infants are known to have about a 20 per cent chance of developing the disorder.

"We need to see what's happening before autism develops," says Murphy. His team also hopes to be able to monitor the progress of at-risk children who do not go on to develop autism in order to identify protective factors in their lifestyles.

Journal reference: *Current Biology*, DOI: 10.1016/j.cub.2011.06.009

http://www.newscientist.com/article/dn20640-sleeping-babies-can-hear-youre-upset.html?full=true&print=true

Quantum magic trick shows reality is what you make it

- 18:00 22 June 2011 by **Anil Ananthaswamy**

It's easy with a quantum ball (Image: Rubberball/Corbis)

Conjurers frequently appear to make balls jump between upturned cups. In quantum systems, where the properties of an object, including its location, can vary depending on how you observe them, such feats should be possible without sleight of hand. Now this startling characteristic has been demonstrated experimentally, using a single photon that exists in three locations at once.

Despite quantum theory's knack for explaining experimental results, some physicists have found its weirdness too much to swallow. Albert Einstein mocked entanglement, a notion at the heart of quantum theory in which the properties of one particle can immediately affect those of another regardless of the distance between them. He argued that some invisible classical physics, known as "hidden-variable theories", must be creating the illusion of what he called "spooky action at a distance".

A series of painstakingly designed experiments has since shown that Einstein was wrong: entanglement is real and no hidden-variable theories can explain its weird effects.

But entanglement is not the only phenomenon separating the quantum from the classical. "There is another shocking fact about quantum reality which is often overlooked," says Aephraim Steinberg of the University of Toronto in Canada.

No absolute reality

In 1967, Simon Kochen and Ernst Specker proved mathematically that even for a single quantum object, where entanglement is not possible, the values that you obtain when you measure its properties depend on the context. So the value of property A, say, depends on whether you chose to measure it with property B, or with property C. In other words, there is no reality independent of the choice of measurement.

It wasn't until 2008, however, that Alexander Klyachko of Bilkent University in Ankara, Turkey, and colleagues devised a feasible test for this prediction. They calculated that if you repeatedly measured five different pairs of properties of a quantum particle that was in a superposition of three states, the results would differ for the quantum system compared with a classical system with hidden variables.

That's because quantum properties are not fixed, but vary depending on the choice of measurements, which skews the statistics. "This was a very clever idea," says Anton Zeilinger of the Institute for Quantum Optics, Quantum Nanophysics and Quantum Information in Vienna, Austria. "The question was how to realise this in an experiment."

Now he, Radek Lapkiewicz and colleagues have realised the idea experimentally. They used photons, each in a superposition in which they simultaneously took three paths. Then they repeated a sequence of five pairs of measurements on various properties of the photons, such as their polarisations, tens of thousands of times.

A beautiful experiment

They found that the resulting statistics could only be explained if the combination of properties that was tested was affecting the value of the property being measured. "There is no sense in assuming that what we do not measure about a system has [an independent] reality," Zeilinger concludes.
Steinberg is impressed: "This is a beautiful experiment." If previous experiments testing entanglement shut the door on hidden variables theories, the latest work seals it tight. "It appears that you can't even conceive of a theory where specific observables would have definite values that are independent of the other things you measure," adds Steinberg.
Kochen, now at Princeton University in New Jersey, is also happy. "Almost a half century after Specker and I proved our theorem, which was based on a [thought] experiment, real experiments now confirm our result," he says.
Niels Bohr, a giant of quantum physics, was a great proponent of the idea that the nature of quantum reality depends on what we choose to measure, a notion that came to be called the Copenhagen interpretation. "This experiment lends more support to the Copenhagen interpretation," says Zeilinger.
Journal reference: *Nature*, DOI: 10.1038/nature10119

http://www.newscientist.com/article/dn20600-quantum-magic-trick-shows-reality-is-what-you-make-it.html

Rubik's cubes of any size can now be solved

- 12:31 30 June 2011 by **Jacob Aron**

Every single one cracked (Image: Dominick Reuter)
1 more image

Only the most hardcore puzzle-solvers ever go beyond the standard 3x3x3 Rubik's cube, attempting much larger ones such as those pictured on the right. Now an algorithm has been developed that can solve a Rubik's cube of any size. It might offer clues to humans trying to deal with these tricky beasts.

Rubik's cube science got a boost last year when a team led by programmer Tomas Rokicki of Palo Alto, California, showed that even the most scrambled standard Rubik's cube can be solved in 20 moves or less. That feat was a big deal: the figure has been dubbed "God's number", the assumption being that the Almighty couldn't solve it faster. But that result didn't shed light on the monster cubes.

So Erik Demaine, a computer scientist at the Massachusetts Institute of Technology, set out to find a general algorithm for solving a cube with any side-length – of *n* squares.

The new approach differs from that of Rokicki's. The latter used a "brute force" method, relying on computers borrowed from Google to check all 43 quintillion possible solutions, but Demaine says doing the same for larger cubes would be impossible. "You can't solve all values of *n* with computational search," he explains.

Cubie paths

Instead, Demaine's team started by looking at a method Rubik's cube enthusiasts commonly use to quickly solve the puzzle. Essentially, you try to move a single square, or "cubie", into the desired position while leaving the rest of the cube as unchanged as possible. Because it's not possible to move a single cubie without disturbing others, this method is time-consuming, requiring a number of moves that is proportional to n^2.

Demaine and his colleagues found a short-cut. Each cubie has a particular path that will place it in the correct position. His algorithm looks for cubies that all need to go in the same direction, then moves them at the same time. "We found that instead of solving one cubie at a time, you can parallelise that process and solve several," Demaine says.

Grouping cubies with similar paths reduces the number of moves required by a factor of around log *n*. This means that the maximum number of moves that will ever be required for a cube of side *n* is proportional to $n^2/\log n$.

Helping humans

Figuring out a single cubie's path without a computer is no easy task, let alone doing it for the whole cube, so it's unlikely that humans will be able to directly apply this formula. But Demaine reckons it could offer cube-solvers a few tips.

"It gives me a couple of ideas how to solve this thing faster," agrees Stewart Clark, a Rubik's cube enthusiast and physicist at Durham University, UK who owns an 11x11x11 cube.

Clark says it's possible that some of the techniques behind the algorithm could be applied to speeding up other problems that involve searching or sorting through sets of data with a similar mathematical structure to the

cube. "It would need a little bit of tweaking, but there are areas where you might be able to tweak it in the right direction."

So has the Rubik's cube given up all of its secrets? No, says Demaine. Right now his algorithm only gives an approximate value for the number of moves required to solve a cube of any given size: it states that the value is proportional to $n^2/\log n$. His first task is to work out how to turn that into an exact number for given sizes of cube.

Less-scrambled cubes

Even then, however, a further puzzle remains. Demaine's current algorithm only finds the most efficient way to solve a cube if it is in the most scrambled state of that cube possible. But he would also like to explore whether an algorithm exists for finding the number of moves required by less-scrambled cubes.

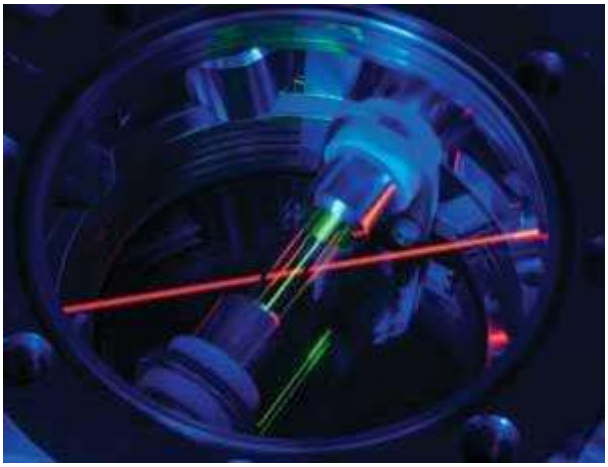
"Suppose someone takes a solved 20x20x20 Rubik's cube and makes five moves - can you figure out [from that scrambled state] what those five moves were?" he asks. In other words, can you solve it in five moves? He suspects that you cannot, but has yet to prove it. "We don't know."

For Rokicki, the next task is to find an algorithm that can solve any 4x4x4 cube in the fewest possible moves. "It would probably take more CPU time to solve a single random 4x4x4 position than we used to prove God's number for the 3x3x3."

http://www.newscientist.com/article/dn20636-rubiks-cubes-of-any-size-can-now-be-solved.html?full=true&print=true

One step closer to a nuclear timekeeper

- 29 June 2011 by **David Shiga**
- Magazine issue 2819



What makes thorium tick? (Image: Corey Campbell, Georgia Institute of Technology)

WHY would anyone want to build a super-precise clock in the hope that its tick drifts as time goes by? That's what is driving a team that is trying to build the first nuclear clock, with a tick based on the antics of an atomic nucleus. They reason that the behaviour of the clock could show whether certain forces of nature fluctuate in a way that is predicted by some exotic theories of physics.

The most accurate clocks we have are the so-called atomic clocks. They exploit the fact that an atom of caesium, or some other element, emits visible light or microwaves when one of its electrons drops from a high energy state to a lower one. The frequency of these emissions are so precisely predictable that it can act like the tick of a highly accurate clock. Atomic clocks provide the super-accurate timing needed for GPS satellites and to define the length of a second.

A nuclear clock would be different. Instead of relying on light waves emitted by electrons, it would use radiation emitted when the nucleus is excited to a high energy state, and then drops into a lower energy state. "All the electrons are going to sit in exactly the same place as they normally sit," says Alex Kuzmich of the Georgia Institute of Technology in Atlanta. "It's the nucleus that's going to make a transition."

The trouble is that most such transitions within the nucleus emit high-energy X-rays or gamma rays, and these are tough to work with. An exception is thorium-229, an isotope produced in nuclear reactors that has three fewer neutrons than the only naturally occurring isotope, thorium-232. Its nucleus is predicted to emit and absorb ultraviolet light.

As a first step towards building a nuclear clock, Kuzmich and his colleagues have recorded the light given off by excited electrons in thorium-229 ions. The team fired a laser at a solid thorium-229 target in a vacuum chamber. This stripped electrons from some of the material, and vaporised it. A second set of lasers then slowed and cooled this ion vapour, while magnetic fields kept the ions from hitting the chamber walls. A third laser then excited the electrons in these trapped ions. The team was able to record the light given off as the electrons in individual ions dropped to a lower energy state (*Physical Review Letters*, DOI: 10.1103/PhysRevLett.106.223001).

To turn this set-up into a nuclear clock, the team now needs to hit upon the precise frequency of light needed to excite the thorium-229 nuclei - and observe the light emitted when it drops back in energy. "If one of the ions makes this nuclear transition, we should be able to observe it right away," says Kuzmich. This will require painstakingly firing lasers of different frequencies at the trapped ions, watching for when they emit light.

The team's results are "really exciting" and "a huge step" towards making a nuclear clock, says Eric Hudson of the University of California, Los Angeles, who is not a member of the team and is working on an

alternative approach. He and his colleagues plan to hit a thorium-229 target using light from a particle accelerator, which can be more easily tuned across a wide range of wavelengths than a laser.
A nuclear clock could be used to test whether the strength of the fundamental forces of nature changes over time. Some theories, including string theory, predict that they should drift, and there are some tentative hints of such changes from astronomical measurements.
The frequencies of radiation emitted by an atomic clock are closely tied to a parameter called alpha, which governs the strength of the electromagnetic force. By contrast, the frequency of a nuclear clock depends on the strength of the strong nuclear force. So if the relative strength of these forces changes, it would show up as a divergence in the time kept by a nuclear clock compared with an atomic clock, a technique that could be the most sensitive yet for seeing this effect.

Lasers Could Help Build a Nuclear Clock

If nuclear clocks are possible, what about nuclear lasers? Thorium could be the key to building those too.
Lasers have been made from a wide variety of materials. To date, they all work by exciting electrons that are either floating freely or in atoms, prompting the emission of a burst of light. In atoms of the isotope thorium-229, the energy levels in the nucleus are arranged in such a way that the nucleus could also be made to emit ultraviolet light (see main story).
Eugene Tkalya of the Institute of Nuclear Physics at Moscow State University in Russia suggests making a thorium laser by firing conventional ultraviolet lasers at crystals made mostly of lithium, calcium, aluminium and fluorine, with a sprinkling of thorium. Recent experiments suggest the electrons in this material will not interfere with the propagation of light emitted by thorium nuclei (*Physical Review Letters*, DOI: 10.1103/PhysRevLett.106.162501). In other materials, this effect would make a nuclear laser fizzle.
Though conventional lasers that emit UV light already exist, Tkalya says that thorium lasers could form the light source in a nuclear thorium clock, and help us uncover the properties and behaviour of the thorium-229 nucleus's excited state.

http://www.newscientist.com/article/mg21128194.000-one-step-closer-to-a-nuclear-timekeeper.html

Alex Bellos: Tell me all about your favourite number

- 29 June 2011 by **Justin Mullins**
- Magazine issue 2818

On a numerical adventure (Image: Michael Duerinick)

What's your favourite number and why? A mathematics writer wants to know the answer. Yes, really

Why are you interested in favourite numbers?

I give popular talks about mathematics and I'm often asked about my favourite number. I don't have an emotional reaction to numbers and so don't have a favourite. So at first I was annoyed by these questions but then I became puzzled. I began to ask around and found that lots of people have a personal relationship with numbers. I thought it would be fun to try and quantify this.

So you have set up a website to find out (favouritenumber.net). What kind of response have you had?

It's really caught people's imagination. My survey only launched a few weeks ago and already more than 5100 people have responded. I'm going to leave it up until September or so, to get as many responses from as many cultures as possible. As well as asking people to give their favourite number and describe why they chose it, I also ask where they are from and their age and gender.

What do you expect to find?

I'll be able to say, for example, that *x* number of people voted for the number 25, that 30 per cent of them were women and break this down by age and country. But the most interesting stuff is the fascinating reasons people give for their choices.

What are they saying about their favourite numbers?

People have given an amazing range of responses. For example, one person might say they like 8 because it has a beautiful shape, another because it is $2 \times 2 \times 2$ and another because that's the number on the football shirt he or she wears.

Are any strange numbers coming up?

Less obvious numbers come up surprisingly regularly. Some are physical constants and there are quite a lot of references to popular culture. For example, the number 73 has a cult following because of a sketch in the comedy show *The Big Bang Theory* in which 73 is described as the "Chuck Norris of numbers", not least because it is a mirror prime: both 73 and 37 are primes.

Have you seen patterns in the choices?

Patterns seem to be emerging although I haven't done a detailed analysis yet. These patterns raise interesting questions. For example, when people choose birthdays, certain types of date seem more popular than others.

Why is this? Others choose a number because it has a certain mathematical property - it is a palindrome, for example. But why are these properties more popular than others?

Why do you think people have favourite numbers?

Humans seem hard-wired to make impersonal things seem personal and so try to personalise numbers by projecting something about themselves onto them. For people who aren't mathematicians, it is a way of feeling in control. I think this touches the issue of why some people are scared of maths and why others love it. Your personality seems to be an important factor in your choice, for example, whether you are superstitious or not.

Profile

Alex Bellos is author of *Alex's Adventures in Numberland*, published as *Here's Looking at Euclid* in the US. To enter your favourite number in his survey, and the reasons why you like it, go to favouritenumber.net

http://www.newscientist.com/article/mg21028186.300-alex-bellos-tell-me-all-about-your-favourite-number.html?full=true&print=true

The Facelessness of Mass Destruction

By WILLARD SPIEGELMAN


Corbis

The 2,711 concrete pillars—of different heights but identical lengths and widths—rise from the ground like blank tombstones.

Berlin is a vibrant city haunted by history and death. Peter Eisenman's Memorial to the Murdered Jews of Europe opened there in May 2005. If you came upon it unknowingly, you might mistake it for a bizarre playground designed by the obsessive-compulsive Donald Judd, or a cousin to Daniel Buren's installation of black-and-white columns of different lengths in the courtyard of the Palais Royal in Paris. Occupying an open plaza near the Brandenburg Gate, across the street from the public Tiergarten and around the corner from the shining commercial towers of Potsdamer Platz, the memorial's 2,711 concrete *stelae* (funeral pillars)—of different heights but identical lengths and widths—extend in shining rows, 54 of them going north-south, and 87 heading east-west at right angles.

Some of the stelae at the periphery are flush with the ground, like blank tombstones. As you move toward the site's center, the flat grade deepens and you find yourself sinking slowly among taller pillars. Claustrophobia replaces openness; two people cannot walk abreast down the aisles. The site is not quite a labyrinth, because all of its lines are straight, but you feel trapped.

Although officially forbidden to do so, children leap from stele to stele. (A helpful attendant told me that the memorial lacks sufficient staff to patrol the site properly.) A sense of ordinariness, even of carnival on sunny days, prevails on top, contrasting with the dark, eerie shadows beneath. This disparity makes a point more forcefully than words can: that even in the midst of normal life, strangeness—or much worse—can overwhelm you.

View Full Image

Michel Setboun/Corbis

Another view of Peter Eisenman's Memorial to the Murdered Jews of Europe.

Memorials and gravesites are synonymous with naming, except for places like a Tomb of the Unknowns. In the case of six million European Jews who perished in the Holocaust, names are often impossible to come by. Despite the best efforts of historians and the work of Yad Vashem in Jerusalem, information for about half of the victims—the times and places of their deaths—may be forever lost. Mr. Eisenman's stark pillars represent the facelessness of mass destruction.

The above-ground memorial constitutes only part of the experience of being here. For countless residents and tourists who meander by it on their daily rounds, it does what Robert Lowell said of Augustus Saint-Gaudens's bas-relief to Col. Robert Gould Shaw and his black soldiers, on Boston's Beacon Street across from the Massachusetts State Capitol: It "sticks like a fish bone in the city's throat." A century after the Civil War, the sculpture reminded Lowell of the work of liberation still to be done.

Mr. Eisenman's construction—bland and gripping at once—does the same.

Blandness and anonymity are banished below ground, in the rooms of the Information Center, where visitors can attach names, faces and personal details to some of the Holocaust's victims. At the end of a long corridor that presents in words and images a capsule history of Jews during the Third Reich (1933-45), you face magnified photo portraits of six people, standing in for all the others. Then come four darkened, somber square rooms, each balancing the enormity of the tragedy with the individuality of single victims, their voices and stories. Each chamber contains visual reminders of the stelae above: rectangular benches, horizontal floor markers and vertical illuminations.

Take, for example, "The Room of Dimensions." On the walls you find the countries of origin and numbers of victims, from Albania (100) and Denmark (116) to Russia (950,000-1,050,000) and Poland (2.9 million to 3.1 million): Mere statistics. On the floor you read, as if they were epitaphs, illuminated transcriptions of snippets from postcards, letters, diaries—some of which reached their intended recipients, others of which were recovered miraculously after the war. Twelve-year-old Judith Wischnjatskaja bids farewell to her father in a note found by a member of the Red Army. The Viennese writer Oskar Rosenfeld (1884-1944) describes the resettlement from the Lodz ghetto and asks: "If something like that was possible, what else would be? Why war still? Why hunger still? Why a world still?" Each of the 15 tells a different story; each tells the same story.

"Claustrophobia replaces openness as you experience the unnameable on a colossal scale."

For many Americans, the most moving testimony to the victims of Sept. 11, 2001, came a year after the attacks when, at Ground Zero, the names of the dead were read out, alphabetically. Prayers and political commentary sounded bloated or empty by comparison, as they would here in Berlin. In the room called "Collecting Traces" you sit on slabs and hear names and modest obituaries of ordinary people in German and English. You hear things like "the exact circumstances of her death are not known." To read all the names, we are told—even if we had them—would take more than 6½ years.

A third room shows representative families from different countries. We read of the Czechoslovakian Samuel Antman, who survived. In 1945, after the liberation, he sat down to make a list of his relatives who did not. He named 92 of them. In 1980, he did it again and remembered only 26. Already he had begun to forget.

W.B. Yeats, in "Easter, 1916," his elegy about the failed uprising in Dublin against British rule, refers to the Irish rebels, at first, only generically—"that woman," "this man," "this other man." At the poem's end, he says that "our part" is "to murmur name upon name," like a mother singing her child to sleep. Only now can he "write it out in a verse" and identify "MacDonagh and MacBride / And Connolly and Pearse." To remember means to specify.

For a full history of Jews in Germany, one goes to Daniel Libeskind's encyclopedic Jewish Museum, which traces settlement, anti-Semitism, assimilation and acculturation in addition to the Holocaust. For an experience of the un-nameable on a colossal scale, as well as snapshots of commonplace people, one comes here, to Mr. Eisenman's memorial, where the materiality of stone competes and cooperates with the ephemerality of language and names, and where at least some of the names achieve a permanence of their own.

—Mr. Spiegelman is the Hughes Professor of English at Southern Methodist University.
http://online.wsj.com/article/SB10001424052702303936704576399912634957114.html?mod=WSJ_LifeStyle_Lifestyle_5

High Social Rank Comes at a Price, Wild Baboon Study Finds

In a finding that has implications in the study of social hierarchies, researchers led by Princeton ecologist Laurence Gesquiere have learned that the highest-ranking, or alpha, males in wild baboon populations suffer higher stress levels than their lower-ranked counterparts. The study involved 125 adult male baboons in Kenya's Amboseli Basin. This adult male is vigilantly monitoring the activities of other members of his social group before taking action. (Credit: Photo by Jeanne Altmann)

ScienceDaily (July 14, 2011) — Being at the very top of a social hierarchy may be more costly than previously thought, according to a new study of wild baboons led by a Princeton University ecologist.

A new study, "Life at the Top: Rank and Stress in Wild Male Baboons," published in the July 15 issue of the journal *Science* found that in wild baboon populations, the highest-ranking, or alpha, males have higher stress-hormone levels than the highly ranked males below them, known as beta males -- even during periods of stability. The findings have implications in the study of social hierarchies and of the impact of social dominance on health and well-being, a subject of interest among researchers who study human and other animal populations.

"An important insight from our study is that the top position in some animal -- and possibly human -- societies has unique costs and benefits associated with it, ones that may persist both when social orders experience some major perturbations as well as when they are stable," said lead author Laurence Gesquiere, an associate research scholar in Princeton's Department of Ecology and Evolutionary Biology. "Baboons are not only genetically closely related to humans, but like humans they live in highly complex societies."

Gesquiere works in the laboratory of Jeanne Altmann, Princeton's Eugene Higgins Professor of Ecology and Evolutionary Biology Emeritus. The study involved 125 adult male members of five social groups of fully wild-living baboons in Kenya's Amboseli Basin. Individual life histories and behavioral data have been collected from the population for four decades by Altmann's research group.

For the new study, researchers measured levels of both a stress hormone called glucocorticoid and testosterone in fecal samples over a period of nine years. The data collected in the study is five to 10 times greater in duration, number of groups and number of individual males than any data previously available for

any nonhuman primate, which allowed researchers to control for important variables that might have affected stress hormones, said Gesquiere.

According to study co-author and Duke University biology professor Susan Alberts, the large sample size and lengthy period of observation also meant the results didn't depend on characteristics of particular individual males, but rather reflect the long-term effects of dominance rank.

"We've known for decades that alpha males have an advantage in reproduction, but these results show that life at the top has a real downside, and that being an alpha male comes at a real cost," said Alberts.

Both Gesquiere and Alberts pointed out that the baboons' heightened stress levels are most likely based on the energy they must expend to maintain their social position, rather than psychological factors. For instance, alpha males are involved in a higher rate of fighting and mate guarding than beta males. They do not differ, however, in the rate of challenges to their status, which is considered a psychological stressor, or in the amount of grooming they receive from adult and juvenile females, which is a measure of psychological support.

"Baboons are likely to be good models to provide insights for identifying the ideal position in a complex society under different conditions," Altmann said of the study's potential insights into research on human behavior. "Humans also live in stratified societies, and social status is well known to be associated with some but not all health outcomes in humans.

"It has been difficult to identify many of the mechanisms behind these associations," she added. "Our results point to the need for research that will identify and evaluate the specific costs and benefits of various status positions, in various species, types of organizations and groups, and under different ecological conditions."

In addition to Gesquiere, Alberts and Altmann, contributors to the paper include other members of Altmann's lab: research specialist Niki Learn; Patrick Onyango, who received his Ph.D. in May; and former lab assistant Carolina Simao. The research was funded by the National Science Foundation, the National Institute of Aging and the National Institute of Mental Health.

Story Source:

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Journal Reference:

1. Laurence R. Gesquiere, Niki H. Learn, M. Carolina M. Simao, Patrick O. Onyango, Susan C. Alberts, Jeanne Altmann. **Life at the Top: Rank and Stress in Wild Male Baboons**. *Science*, 2011; 333 (6040): 357-360 DOI: 10.1126/science.1207120

http://www.sciencedaily.com/releases/2011/07/110714142137.htm

Dramatic Climate Swings Likely as World Warms: Ancient El Niño Clue to Future Floods

Flooded road in Queensland, Australia. (Credit: © Johan Larson / Fotolia)

ScienceDaily (July 15, 2011) — Dramatic climate swings behind both last year's Pakistan flooding and this year's Queensland floods in Australia are likely to continue as the world gets warmer, scientists predict.

Researchers at the Universities of Oxford and Leeds have discovered that the El Niño Southern Oscillation (ENSO), the sloshing of the warmest waters on the planet from the West Pacific towards the East Pacific every 2-7 years, continued during Earth's last great warm period, the Pliocene.

Their results suggest that swings between the two climatic extremes, known as El Niño and La Niña, may even have occurred more frequently in the warmer past and may increase in frequency in the future. Extreme ENSO events cause droughts, forest fires and floods across much of the world as well as affecting fishery production.

Reporting in the journal *Paleoceanography*, the team of geochemists and climate modellers use the Pliocene as a past analogue and predictor of the workings of Earth's future climate.

The Pliocene (which lasted from 5 to 3 million years ago) had carbon dioxide levels similar to the present day, with global mean temperatures about 2-3ºC higher, so it is a useful test-ground for climate research.

Lead Scientist Nick Scroxton from Oxford University's Department of Earth Sciences said: 'We know from previous studies that the mean state of the Pacific during the warm Pliocene was similar to the climate patterns observed during a typical El Niño event that we see today.

'However, until recently it was believed that a warmer Pacific would reduce the climate swings that cause the dramatic weather extremes throughout the region leading to a permanent state of El Niño. What we didn't expect was that climatic variability would remain strong under these warmer conditions.'

The team combined experiments performed on the Met Office Hadley Centre climate model, HadCM3, with the analysis of the chemical composition of lots of individual shells of small organisms, known as foraminifera.

These were collected from a deep sea sediment core in the East Equatorial Pacific, and provided a record of temperature in the upper layer of the ocean through time. They discovered that the range of temperatures experienced by these organisms during the Pliocene, was higher than what would be expected from just the seasonal cycle.

The extra variation in temperature can be explained by the additional extreme temperature swings provided by the El Niño/La Niña system.

The authors say the agreement in findings from both ocean data and modelling leaves little doubt that ENSO will persist in a warmer world. Earlier this year a team from Japan studying corals from the same period showed climatic variability in the western Pacific on a similar scale to today, questioning the idea of a permanent El Niño during the Pliocene.

This new study goes further, showing that the oscillation is Pacific-wide, and is likely to be caused by the El Niño/La Niña. This suggests that our warmer future will continue to be dogged, maybe even more regularly, by extreme climatic events.

Story Source:

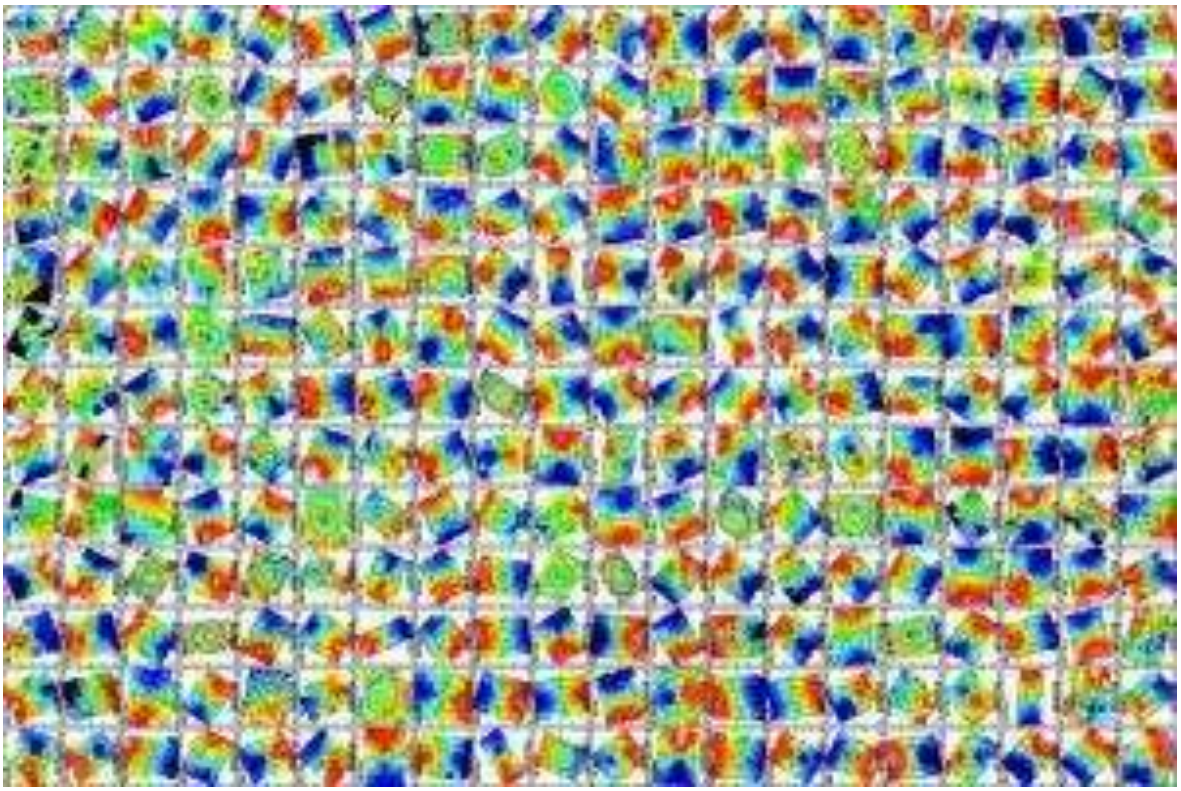
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Oxford**.

Journal Reference:

1. N. Scroxton, S. G. Bonham, R. E. M. Rickaby, S. H. F. Lawrence, M. Hermoso, A. M. Haywood. **Persistent El Niño–Southern Oscillation variation during the Pliocene Epoch**. *Paleoceanography*, 2011; 26 (2) DOI: 10.1029/2010PA002097

http://www.sciencedaily.com/releases/2011/07/110714103249.htm

Most Elliptical Galaxies Are 'Like Spirals'



Maps of the observed velocity of the stars in the Atlas3D survey. Red/blue colours indicate stars moving away/towards us respectively. Fast rotating and disk-like galaxies are characterised by two large and symmetric red/blue peaks at the two sides of the centre and constitute the vast majority of the sample. (Credit: OU/Cappellari)

ScienceDaily (July 15, 2011) — The majority of 'elliptical' galaxies are not spherical but disc-shaped, resembling spiral galaxies such as our own Milky Way with the gas and dust removed, new observations suggest.

The results come from Atlas3D, a survey of all 260 early-type ('elliptical' and 'lenticular') galaxies in a well-defined volume of the nearby universe. Atlas3D shows a much closer link between 'elliptical' galaxies and spiral galaxies than previously thought. The findings are likely to change our ideas of how galaxies form and see astronomy text-books rewritten.

A report of the research, by the international Atlas3D team, is published in an upcoming issue of *Monthly Notices of the Royal Astronomical Society*.

'Because we rely on optical images, up until now it has been very difficult to separate discs of stars seen face-on from rounder, spherical balls of stars seen edge-on,' said Dr Michele Cappellari of Oxford University, a Royal Society Research Fellow who is the UK lead of the Atlas3D project. 'But because stars in a thin disc rotate much faster than those in a spheroid, obtaining maps of stellar motions for all elliptical galaxies in the sample, we have shown that out of these 66% are disc-like.'

The findings suggest that the idea that galaxies can be clearly separated into two different 'families', spiral galaxies and elliptical galaxies, reflecting two distinct paths to galaxy formation, is inaccurate.

This 'two families' approach was famously visualised in Edwin Hubble's 'tuning fork' diagram of 1936 in which elliptical nebulae, which consist of more spherical groups of stars, split off into two prongs of spiral galaxies (with and without bars). The Atlas3D results suggest that this tuning fork should be replaced with a 'comb-like' diagram where elliptical galaxies are parallel to spirals and linked to them along the teeth of the comb while only a few true ellipticals are separated into the handle.

'According to our survey only a small fraction of elliptical galaxies, the 'slow rotators', are genuine spheroids. It reveals a strong family resemblance between elliptical and spiral galaxies once we can adjust for whether we are seeing them face-on or from the side,' said Dr Cappellari. 'This close relationship will need to be considered in any future models of how galaxies form. It's an exciting moment, after four years of work in the project, we have the final piece of the puzzle which enables us to say that text-books used to teach astronomy for over 70 years now need to be revised.'

The team, led by Dr Michele Cappellari of Oxford University's Department of Physics, Eric Emsellem, Davor Krajnovic (ESO, Germany) and Richard McDermid (Gemini, USA), compiled their maps of stellar motions from 40 nights of observations using the SAURON integral-field spectrograph at the 4.2-m William Hershel Telescope on the Canary Islands.

A report of the research is to be published in an upcoming issue of *Monthly Notices of the Royal Astronomical Society*. Lead author Dr Michele Cappellari was supported through a Royal Society Research Fellowship.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Oxford**.

Journal Reference:

1. Michele Cappellari et al. **The Atlas3D project -- VII. A new look at the morphology of nearby galaxies: the kinematic morphology-density relation**. *Monthly Notices of the Royal Astronomical Society*, 2011

http://www.sciencedaily.com/releases/2011/07/110714101631.htm

Swarms of Locusts Use Social Networking to Communicate

Social studies of Facebook and Twitter have been adapted to gain a greater understanding of the swarming behaviour of locusts. (Credit: iStockphoto/Ruvan Boshoff)

ScienceDaily (July 15, 2011) — Social studies of Facebook and Twitter have been adapted to gain a greater understanding of the swarming behaviour of locusts. The enormous success of social networking sites has vividly illustrated the importance of networking for humans; however for some animals, keeping informed about others of their kind is even more important.

In a study published on July 15, 2011, in the Institute of Physics and German Physical Society's *New Journal of Physics*, researchers have shown that swarming, a phenomenon that can be crucial to an animal's survival, is created by the same kind of social networks that humans adopt.

Since the 1980s, scientists have been programming computer models to realistically reproduce flocks of birds, schools of fish, herds of quadrupeds and swarms of insects. However, the question of how these groups coordinate to move together has remained a mystery.

It remains more of a mystery when each organism can only see a small area around them, when they are affected by unpredictable changes in the environment, and when there is no clear leader of the collective behaviour.

Researchers from the Max Planck Institute for Physics of Complex Systems, as well as a US-based scientist supported by the National Science Foundation, addressed this problem from a different perspective: network science.

They used ideas from previous studies on opinion formation in social networks, such as Facebook and Twitter, and applied them to a previous study of 120 locust nymphs marching in a ring-shaped arena in the lab.

Studies have shown that the decisions you make, or the opinion you have, are strongly influenced by the decisions and opinions of your friends, or more generally, your contacts in your social network.

Locusts rely heavily on swarming as they are in fact cannibalistic. As they march across barren deserts, locusts carefully keep track of each other so they can remain within striking distance to consume one another -- a cruel, but very efficient, survival strategy.

The study used a computer model to explicitly simulate the social network among locusts and found that the most important component needed to reproduce the movements seen in the lab is the social interactions that occur when locusts, walking in one direction, convince others to walk in the same direction.

The researchers state that it may not be obvious that animals are creating the equivalent of our human social networks however this is the precise mechanism behind swarming transition.

One of the study's authors, Gerd Zschaler, said, "We concluded that the mechanism through which locusts agree on a direction to move together (sometimes with devastating consequences, such as locust plagues) is the same we sometimes use to decide where to live or where to go out: we let ourselves be convinced by those in our social network, often by those going in the opposite direction."

"We don't necessarily pay more attention to those doing the same as us, but many times [we pay more attention] to those doing something different."

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Institute of Physics**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Huepe et al. **Adaptive-network models of swarm dynamics**. *New Journal of Physics*, 15 July 2011 DOI: 10.1088/1367-2630/13/7/073022

http://www.sciencedaily.com/releases/2011/07/110714191435.htm

Editing the Genome: Scientists Unveil New Tools for Rewriting the Code of Life

Researchers have unveiled genome-engineering technologies capable of fundamentally re-engineering genomes from the nucleotide to the megabase scale. Treating the chromosome as both an editable and an evolvable template, the researchers have demonstrated methods to rewrite a cell's genome through powerful new tools for biotechnology, energy and agriculture. (Credit: iStockphoto/Zmeel Photography)

ScienceDaily (July 15, 2011) — The power to edit genes is as revolutionary, immediately useful and unlimited in its potential as was Johannes Gutenberg's printing press. And like Gutenberg's invention, most DNA editing tools are slow, expensive, and hard to use -- a brilliant technology in its infancy. Now, Harvard researchers developing genome-scale editing tools as fast and easy as word processing have rewritten the genome of living cells using the genetic equivalent of search and replace -- and combined those rewrites in novel cell strains, strikingly different from their forebears.

"The payoff doesn't really come from making a copy of something that already exists," said George Church, a professor of genetics at Harvard Medical School who led the research effort in collaboration with Joe Jacobson, an associate professor at the Media Lab at the Massachusetts Institute of Technology. "You have to change it -- functionally and radically."

Such change, Church said, serves three goals. The first is to add functionality to a cell by encoding for useful new amino acids. The second is to introduce safeguards that prevent cross-contamination between modified organisms and the wild. A third, related aim, is to establish multi-viral resistance by rewriting code hijacked by viruses. In industries that cultivate bacteria, including pharmaceuticals and energy, such viruses affect up to 20 percent of cultures. A notable example afflicted the biotech company Genzyme, where estimates of losses due to viral contamination range from a few hundred million dollars to more than $1 billion.

In a paper scheduled for publication July 15 in *Science*, the researchers describe how they replaced instances of a codon -- a DNA "word" of three nucleotide letters -- in 32 strains of E. coli, and then coaxed those partially-edited strains along an evolutionary path toward a single cell line in which all 314 instances of the codon had been replaced. That many edits surpasses current methods by two orders of magnitude, said Harris Wang, a research fellow in Church's lab at the Wyss Institute for Biologically Inspired Engineering who shares lead-author credit on the paper with Farren Isaacs, an assistant professor of molecular, cellular and developmental biology at Yale University and former Harvard research fellow, and Peter Carr, a research scientist at the MIT Media Lab.

In the genetic code, most codons specify an amino acid, a protein building block. But a few codons tell the cell when to stop adding amino acids to a protein chain, and it was one of these "stop" codons that the Harvard researchers targeted. With just 314 occurrences, the TAG stop codon is the rarest word in the E. coli genome, making it a prime target for replacement. Using a platform called multiplex automated genome engineering, or MAGE, the team replaced instances of the TAG codon with another stop codon, TAA, in living E. coli cells. (Unveiled by the team in 2009, the MAGE process has been called an evolution machine for its ability to accelerate targeted genetic change in living cells.)

While MAGE, a small-scale engineering process, yielded cells in which TAA codons replaced some but not all TAG codons, the team constructed 32 strains that, taken together, included every possible TAA replacement. Then, using bacteria's innate ability to trade genes through a process called conjugation, the researchers induced the cells to transfer genes containing TAA codons at increasingly larger scales. The new method, called conjugative assembly genome engineering, or CAGE, resembles a playoff bracket -- a hierarchy that winnows 16 pairs to eight to four to two to one -- with each round's winner possessing more TAA codons and fewer TAG, explains Isaacs, who invokes "March Madness."

"We're testing decades-old theories on the conservation of the genetic code," Isaacs said. "And we're showing on a genome-wide scale that we're able to make these changes."

Eager to share their enabling technology, the team published their results as CAGE reached the semifinal round. Results suggested that the final four strains were healthy, even as the team assembled four groups of 80 engineered alterations into stretches of the chromosome surpassing 1 million DNA base pairs. "We encountered a great deal of skepticism early on that we could make so many changes and preserve the health of these cells," Carr said. "But that's what we've seen."

The researchers are confident that they will create a single strain in which TAG codons are completely eliminated. The next step, they say, is to delete the cell's machinery that reads the TAG gene -- freeing up the codon for a completely new purpose, such as encoding a novel amino acid.

"We're trying to challenge people," Wang said, "to think about the genome as something that's highly malleable, highly editable."

This research was funded by U.S. Department of Energy and the National Science Foundation.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Harvard Medical School**, via EurekAlert!, a service of AAAS. The original article was written by R. Alan Leo.

Journal Reference:

1. Farren J. Isaacs, Peter A. Carr, Harris H. Wang, Marc J. Lajoie, Bram Sterling, Laurens Kraal, Andrew C. Tolonen, Tara A. Gianoulis, Daniel B. Goodman, Nikos B. Reppas, Christopher J. Emig, Duhee Bang, Samuel J. Hwang, Michael C. Jewett, Joseph M. Jacobson, George M. Church. **Precise Manipulation of Chromosomes in Vivo Enables Genome-Wide Codon Replacement**. *Science*, 2011; 333 (6040): 348-353 DOI: 10.1126/science.1205822

http://www.sciencedaily.com/releases/2011/07/110714142130.htm

Brainy Lizards Pass Test for Birds

Puerto Rican anoles, Anolis evermanni, were tested on a food-finding apparatus normally used on birds. The lizards showed they could solve a novel problem, remember solutions and "unlearn" incorrect approaches. (Credit: Manuel Leal, Duke University)

ScienceDaily (July 12, 2011) — Tropical lizards may be slow. But they aren't dumb. They can do problem-solving tasks just as well as birds and mammals, a new study shows.

A Duke University experiment tested Puerto Rican anoles on several cognitive tasks and found they can learn and remember to solve a problem they've never faced before. The results challenge the scientific stereotype that reptiles have limited cognitive abilities and methods for finding food.

The lizards' success on a worm-based test normally used on birds was "completely unexpected," said Duke biologist Manuel Leal, who led the study.

He tested the lizards using a wooden block with two wells, one that was empty and one that held a worm but was covered by a cap. Four lizards, two male and two female, passed the test by either biting the cap or bumping it out of the way.

The lizards solved the problem in three fewer attempts than birds need to flip the correct cap and pass the test, Leal said. Birds usually get up to six chances a day, but lizards only get one chance per day because they eat less. In other words, if a lizard makes a mistake, it has to remember how to correct it until the next day, Leal said. He and Duke graduate student Brian Powell describe the experiment and results online in Biology Letters.

Leal's experiment "clearly demonstrates" that when faced with a situation the lizards had never experienced, most of them were able to devise a way to solve the problem. Their ability to "unlearn" a behavior, a skill that some mammalian species have difficulty in, is the mark of a cognitively advanced animal, said Jonathan Losos, a biologist at Harvard who was not involved in the study.

The results "should cause researchers to re-evaluate what they think they know about the evolution of animal cognition," Losos said.

Leal tested the cognition of the Puerto Rican anole, *Anolis evermanni*, after seeing sparrows flip a cap to get a worm and wondering if lizards could do the trick, too.

"They'd put their snout under the little plastic chip and then quickly bump it," Leal said. "They don't do this in the wild."

Even when Leal covered both wells, the lizards chose to flip the cap covering the well with the worm. They had learned to associate the color or brightness of the chip with their reward.

To see if the lizards could reverse this association, Leal next placed the worm under the other cap. At first, all the lizards bumped or bit the formerly lucrative blue cap. But after a few mistakes, two of the lizards figured out the trick. "We named these two Plato and Socrates," Leal said.

The lizards' performance doesn't necessarily mean that reptiles are smarter than birds, said McGill University biologist Louis Lefebvre, who studies learning and behavior in birds and was not involved in the new study. He said a better way to use these new results would be to compare cognitive abilities among reptile species, rather than between reptiles, birds and mammals."We know birds and mammals have bigger brains and that within bird species and within mammal species, the bigger the brain is, the higher the chance of that larger-brained species making it when moving to a new environment," Lefebvre said. "It may be the same with lizards."

Research has shown that large-brained lizards are better than small-brained lizards at colonizing new areas. "My guess would be that the lizard genus in which Manuel Leal has shown fast learning would be among the larger-brained lizards," Lefebvre said.Compared to other lizards, anoles are better at exploiting diverse habitats and they exhibit complex behavior, factors that may favor the evolution of higher-level mental processing. The lizards' ability to perform on the lab tests may also be an indication of the traits that allowed the group to successfully spread across the tropics, Leal said.

He plans to test other species of lizards and compare their brain to body size later this year.

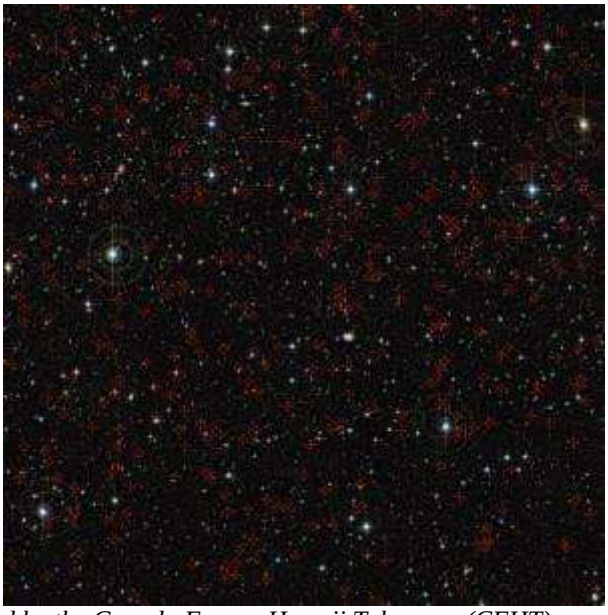
Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Duke University**.

1. Leal, M. and Powell, B. **Behavioral Flexibility and Problem Solving in a Tropical Lizard**. *Biology Letters*, 2011 DOI: 10.1098/rsbl.2011.0480

http://www.sciencedaily.com/releases/2011/07/110712211009.htm

What Activates a Supermassive Black Hole? Galaxy Collisions Not the Culprits, Even in the Jam-Packed Early Universe



This very deep image shows the COSMOS field imaged by the Canada France Hawaii Telescope (CFHT). Huge numbers of very faint galaxies are visible. A new study of this field, combining data from ESO's Very Large Telescope and ESA's XMM-Newton X-ray space observatory has turned up a big surprise. Most of the huge black holes in the centres of active galaxies in the past 11 billion years were not turned on by mergers between galaxies, as had been previously thought. Some of the active galaxies with supermassive black holes at their centers that were used in the new study are marked with red crosses on this picture. (Credit: CFHT/IAP/Terapix/CNRS/ESO)

ScienceDaily (July 14, 2011) — A new study combining data from the European Southern Observatory's Very Large Telescope and the European Space Agency's XMM-Newton X-ray space observatory has turned up a surprise. Most of the huge black holes in the centres of galaxies in the past 11 billion years were not turned on by mergers between galaxies, as had been previously thought.

At the heart of most, if not all, large galaxies lurks a supermassive black hole with a mass millions, or sometimes billions, times greater than that of the Sun. In many galaxies, including our own Milky Way, the central black hole is quiet. But in some galaxies, particularly early on in the history of the Universe [1], the central monster feasts on material that gives off intense radiation as it falls into the black hole.

One unsolved mystery is where the material comes from to activate a sleeping black hole and trigger violent outbursts at a galaxy's centre, so that it then becomes an active galactic nucleus. Up to now, many astronomers thought that most of these active nuclei were turned on when two galaxies merge or when they pass close to each other and the disrupted material becomes fuel for the central black hole. However, new results indicate that this idea may be wrong for many active galaxies.

Viola Allevato (Max-Planck-Institut fur Plasmaphysik; Excellence Cluster Universe, Garching, Germany) and an international team of scientists from the COSMOS collaboration [2] have now looked in detail at more than 600 of these active galaxies in an extensively studied patch of the sky called the COSMOS field [3]. As expected, the astronomers found that extremely brilliant active nuclei were rare, while the bulk of the active galaxies in the past 11 billion years were only moderately bright. But there was a surprise; the new data showed that the majority of these more common, less bright active galaxies, even looking back far into the

past, were not triggered by mergers between galaxies [4]. The results will appear in The *Astrophysical Journal*.

The presence of active galactic nuclei is revealed by the X-rays emitted from around the black hole, which were picked up by ESA's XMM-Newton space observatory. These galaxies were subsequently observed using ESO's Very Large Telescope, which was able to measure the distances to the galaxies [5]. When combined, the observations allowed the team to make a three-dimensional map showing where the active galaxies lie.

"It took more than five years, but we were able to provide one of the largest and most complete inventories of active galaxies in the X-ray sky," said Marcella Brusa, one of the authors of the study.

The astronomers could use this new map to find out how the active galaxies were distributed and compare this with predictions from theory. They could also see how the distribution changed as the Universe aged -- all the way from about 11 billion years ago to almost the present day.

The team found that active nuclei are mostly found in large massive galaxies with lots of dark matter [6]. This was a surprise and not consistent with the prediction from theory -- if most active nuclei were a consequence of mergers and collisions between galaxies it had been expected that they would be found in galaxies with moderate mass (about a trillion times the mass of the Sun). The team found that most active nuclei reside in galaxies with masses about 20 times larger than the value predicted by merger theory.

"These new results give us a new insight into how supermassive black holes start their meals," said Viola Allevato, who is lead author on the new paper. "They indicate that black holes are usually fed by processes within the galaxy itself, such as disc instabilities and starbursts, as opposed to galaxy collisions."

Alexis Finoguenov, who supervised the work, concludes: "Even in the distant past, up to almost 11 billion years ago, galaxy collisions can only account for a small percentage of the moderately bright active galaxies. At that time galaxies were closer together so mergers were expected to be more frequent than in the more recent past, so the new results are all the more surprising."

Notes

[1] The brightest active galaxies were most common in the Universe about three to four billion years after the Big Bang and the less brilliant objects rather later, peaking at around eight billion years after the Big Bang.

[2] The new study is based on two large European astronomical programmes: the XMM-Newton survey of the COSMOS field led by Professor Gunther Hasinger and ESO's zCOSMOS led by Professor Simon Lilly. These programmes are part of the COSMOS initiative, an international endeavour to observe a patch of sky using the NASA/ESA Hubble Space Telescope, ESA's XMM-Newton and NASA's Chandra X-ray space telescopes as well as NASA's infrared Spitzer Space Telescope in addition to observations by ESO's Very Large Telescope and other ground-based facilities.

[3] The COSMOS field is an area about ten times that of the full Moon, in the constellation of Sextans (The Sextant). It has been mapped by a multitude of telescopes at different wavelengths so that a series of studies and investigations can benefit from this wealth of data.

[4] Work published last year from the NASA/ESA Hubble Space Telescope (heic1101: http://www.spacetelescope.org/news/heic1101/) had shown that there was no strong link between active nuclei in galaxies and mergers in a sample of relatively close galaxies. That study looked back about eight billion years into the past but the new work pushes this conclusion three billion years further to a time when galaxies were packed even closer together.

[5] The team used a spectrograph on the VLT to split the faint light from the galaxies up into its component colours. Careful analysis then allowed them to determine the redshift: how much the light has been stretched by the expansion of the Universe since it emerged from the galaxies and hence how distant they are. Because light travels at a finite speed this also tells us how far back in time we are seeing these distant objects.

[6] Dark matter is a mysterious substance that forms an invisible component of most, if not all, galaxies (active or not) -- including our own Milky Way. The authors have estimated the amount of dark matter mass in each galaxy -- which indicates its total mass -- from the distribution of the galaxies in the new study.

More information

This research was presented in a paper that will appear in The *Astrophysical Journal* in July 2011.

The team is composed of V. Allevato (Max-Planck-Institut fur Plasmaphysik [IPP]; Excellence Cluster Universe, Garching, Germany), A. Finoguenov (Max-Planck-Institut fur Extraterrestrische Physik [MPE], Garching, Germany and University of Maryland, Baltimore, USA), N. Cappelluti (INAF-Osservatorio Astronomico de Bologna [INAF-OA], Italy and University of Maryland, Baltimore, USA), T.Miyaji (Universidad Nacional Autonoma de Mexico, Ensenada, Mexico and University of California at San Diego, USA), G. Hasinger (IPP), M. Salvato (IPP, Excellence Cluster Universe, Garching, Germany), M. Brusa (MPE), R. Gilli (INAF-OA), G. Zamorani (INAF-OA), F. Shankar (Max-Planck-Institut fur Astrophysik, Garching, Germany), J. B. James (University of California at Berkeley, USA and University of Copenhagen, Denmark), H. J. McCracken (Observatoire de Paris, France), A. Bongiorno (MPE), A. Merloni (Excellence Cluster Universe, Garching, Germany and MPE), J. A. Peacock (University of California at Berkeley, USA), J. Silverman (University of Tokyo, Japan) and A. Comastri (INAF-OA).

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **European Southern Observatory - ESO**.

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http://www.sciencedaily.com/releases/2011/07/110713092141.htm

Loss of Large Predators Has Caused Widespread Disruption of Ecosystems

Sea otters maintain kelp forests (left) by preying on kelp-grazing sea urchins. In the absence of sea otters, the kelp forest is replaced by an "urchin barren" (right). (Credit: Photos courtesy of J. Estes)

ScienceDaily (July 14, 2011) — The decline of large predators and other "apex consumers" at the top of the food chain has disrupted ecosystems all over the planet, according to a review of recent findings conducted by an international team of scientists and published in the July 15 issue of *Science*. The study looked at research on a wide range of terrestrial, freshwater, and marine ecosystems and concluded that "the loss of apex consumers is arguably humankind's most pervasive influence on the natural world."

According to first author James Estes, a professor of ecology and evolutionary biology at the University of California, Santa Cruz, large animals were once ubiquitous across the globe, and they shaped the structure and dynamics of ecosystems. Their decline, largely caused by humans through hunting and habitat fragmentation, has had far-reaching and often surprising consequences, including changes in vegetation, wildfire frequency, infectious diseases, invasive species, water quality, and nutrient cycles.

The decline of apex consumers has been most pronounced among the big predators, such as wolves and lions on land, whales and sharks in the oceans, and large fish in freshwater ecosystems. But there have also been dramatic declines in populations of many large herbivores, such as elephants and bison. The loss of apex consumers from an ecosystem triggers an ecological phenomenon known as a "trophic cascade," a chain of effects moving down through lower levels of the food chain.

"The top-down effects of apex consumers in an ecosystem are fundamentally important, but it is a complicated phenomenon," Estes said. "They have diverse and powerful effects on the ways ecosystems work, and the loss of these large animals has widespread implications."

Estes and his coauthors cite a wide range of examples in their review, including the following:

- The extirpation of wolves in Yellowstone National Park led to over-browsing of aspen and willows by elk, and restoration of wolves has allowed the vegetation to recover.
- The reduction of lions and leopards in parts of Africa has led to population outbreaks and changes in behavior of olive baboons, increasing their contact with people and causing higher rates of intestinal parasites in both people and baboons.
- A rinderpest epidemic decimated the populations of wildebeest and other ungulates in the Serengeti, resulting in more woody vegetation and increased extent and frequency of wildfires prior to rinderpest eradication in the 1960s.

- Dramatic changes in coastal ecosystems have followed the collapse and recovery of sea otter populations; sea otters maintain coastal kelp forests by controlling populations of kelp-grazing sea urchins.
- The decimation of sharks in an estuarine ecosystem caused an outbreak of cow-nosed rays and the collapse of shellfish populations.

Despite these and other well-known examples, the extent to which ecosystems are shaped by such interactions has not been widely appreciated. "There's been a tendency to see it as idiosyncratic and specific to particular species and ecosystems," Estes said.

One reason for this is that the top-down effects of apex predators are difficult to observe and study. "These interactions are invisible unless there is some perturbation that reveals them," Estes said. "With these large animals, it's impossible to do the kinds of experiments that would be needed to show their effects, so the evidence has been acquired as a result of natural changes and long-term records."

Estes has been studying coastal ecosystems in the North Pacific for several decades, doing pioneering work on the ecological roles of sea otters and killer whales. In 2008, he and coauthor John Terborgh of Duke University organized a conference on trophic cascades, which brought together scientists studying a wide range of ecosystems. The recognition that similar top-down effects have been observed in many different systems was a catalyst for the new paper.

The study's findings have profound implications for conservation. "To the extent that conservation aims toward restoring functional ecosystems, the reestablishment of large animals and their ecological effects is fundamental," Estes said. "This has huge implications for the scale at which conservation can be done. You can't restore large apex consumers on an acre of land. These animals roam over large areas, so it's going to require large-scale approaches."

The paper's coauthors include 24 scientists from various institutions in six countries. Support for the study was provided by the Institute for Ocean Conservation Science, Defenders of Wildlife, White Oak Plantation, U.S. National Science Foundation, NSERC Canada, and NordForsk.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of California - Santa Cruz**. The original article was written by Tim Stephens.

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How Harry Saved Reading . By NORMAN LEBRECHT

AP Photo/Dawn Villella

In 2000, two brothers couldn't wait to read J.K. Rowling's latest.
.Step into my time-travel machine for a short journey back to the early summer of 1997. Bill Clinton is six months into his second term, Tony Blair has just become prime minister in Britain. Princess Diana is eyeing up an unsuitable lover. Apple is dying without Steve Jobs as CEO. Broadband is something people wear around their heads while playing tennis. All so long ago, a time before time.

On June 30 that year, a book was published that blew apart one of the iron rules of publishing. Children's books, a literary agent assured me around this time, when I submitted a proposal, did not sell. Kids had ceased reading, full stop. Only a television tie-in could make chain stores stock a children's book, and even that was unlikely.

Twelve London publishers turned down "Harry Potter and the Philosopher's Stone" before an independent, Bloomsbury, offered J.K. Rowling's agent, Christopher Little, a paltry advance of £2,500. The original edition appeared on June 30, 1997, in a run of 500 copies, most of which went to public libraries. That's how few children were expected to read.

Watch the trailer for 'Harry Potter and the Deathly Hallows,' In the epic finale, the battle between the good and evil forces of the wizarding world escalates into an all-out war.
. The Harry Potter series has cast its spell on millions of fans across the globe. WSJ's Dipti Kapadia visits London's Trafalgar Square to find out if they'll stay true when Daniel Ratcliffe and his co-stars move on from the Potter phenomenon.
.Journal Community
..Sales were sluggish until two awards—one from a confectionery brand, the other an industry award as Children's Book of the Year—put "Harry Potter" into reprint. An American publisher, Scholastic, pitched in with $105,000—a record advance for a children's book—and amended the title to "Harry

Potter and the Sorcerer's Stone" when it brought it out in August 1998, by which time a second volume was out in the U.K.

It is difficult to date exactly when, in the following months, Harry Potter went "viral." My family experience traces the phenomenon to the school library. Our youngest daughter brought home a copy around year four, when she was 9. Her elder sisters commandeered it and insisted that the parents read as well. What Ms. Rowling achieved—long before Warner Bros. adapted her work into films, the last of which will be released next week—was a children-led read-in that crossed all age barriers, uniting families in a primal fireside act of sharing an unfolding story, page by page.

By the time the third volume was delivered to stores, in July 1999 in the U.K. and two months later in the United States, publication was a news-leading event, timed for midnight, with teams of journalists speed-reading until dawn to provide reviews for the final edition. On trains, in airport lounges, in parks and on beaches, everywhere one went, everybody seemed to be reading Harry Potter.

The seventh and final volume, "Harry Potter and the Deathly Hallows," published on July 21, 2007, was the fastest-selling book on record, moving 11 million copies in 24 hours, according to an estimate by the BBC. (The second-best-selling novel of that year, Khaled Hosseini's "A Thousand Splendid Suns," made headlines for selling a million copies in a week.) In all, Ms. Rowling is believed to have sold more than 450 million books. Her cycle has been published in 67 languages, more than any printed book apart from the Bible.

Not since the serial novels of Charles Dickens in the middle of the 19th century had the works of a single author excited such universal and immediate interest. The parallels with Dickens, born 200 years ago next February, are multiple and compelling. "What happens to Little Nell?" crowds shouted in New York harbor to incoming ships that carried the latest installment of "The Old Curiosity Shop." "Is Hermione all right?" booksellers were asked as midnight purchasers scanned the closing pages of "Harry Potter and the Half-Blood Prince," knowing a main character was to die.

Ms. Rowling, who rarely cites influences, has mentioned the death of Sydney Carton in "A Tale of Two Cities" as a formative impression. She has also named Dickens, along with Shakespeare and the Bible, as essential reading for children at school. "David Copperfield" is one of her top recommendations. A pattern of affinities quickly emerges between two authors of very different centuries.

The common factor is hardship. Both writers were exposed to the cruelties of fate at a tender age and embedded these experiences in their main characters. Dickens's father was jailed for debt when the boy was 12, and he was put to work in a shoe-polish "blacking" factory. He drew on the jail memory in "Little Dorrit" and on the child labor in "David Copperfield," "Nicholas Nickleby" and "Oliver Twist." Early adversity turned Dickens into a formidable social reformer, a campaigner for children's rights.

Jo Rowling—she adopted "J.K." on the publishing truism that women authors did not sell—was born in 1965 and was raised in modest, rural comfort. When Ms. Rowling was 15, her mother was diagnosed with degenerative multiple sclerosis; she died, age 45, in December 1990. On a train to London from Manchester earlier that year, Ms. Rowling conceived a series of novels based on a boy wizard. She briefly went to teach English in Portugal, where she contracted a brief marriage, returning penniless with her child to study in Edinburgh. The sickness and death of the author's mother are pivotal to her creation.

From the opening page of the first book, the reader engages with Harry's child's-eye view of a world ruled by imbeciles and malefactors. Harry Potter is an orphan, alone in a world of mediocrities known as "Muggles," who do not appreciate his special gifts. Boarding a train to Scotland at platform 9¾ of

Kings Cross Station, London, he finds acceptance as a wizard, magically empowered but under mortal threat from mysterious enemies.

Harry is a Dickensian archetype, a child of cruelty who inspires in us an urge to make a better world. Alongside Oliver Twist, he is the most celebrated orphan in world literature. Oliver is altogether too perfect, untouched by the evil around him. Harry, more credibly, wrestles with forces of darkness and commands our sympathies.

Like Dickens, Ms. Rowling gives some of her secondary characters onomatopoeic names, informing us before we read another word what kind of person they are. Just as Scrooge, Mr. Bumble, Magwitch and Fagin reflect negative traits in Dickens's world, so do Severus Snape, Quirrell and Filch in that of Harry Potter. Ms. Rowling goes beyond Dickens in imprinting evil into a person's name. Voldemort means flight of death in French, Malfoy is bad faith.

In common with Dickens, Ms. Rowling knows that the reading public will not be insulted by situations that it can recognize. In Hogwarts, she nods to the classic genre of the English school story, established by "Tom Brown's Schooldays" in 1857. Yet she also draws deep on a well of Nordic mythology, plumbed by J.R.R. Tolkien in "The Lord of the Rings" and by Richard Wagner in his Nibelungen tetralogy. Hagrid, Hedwig and Hogsmeade could readily appear in any of these epics.

The force of the Harry Potter cycle lies, as with Wagner, not so much in the originality of its subject matter as in the execution of a panoptic vision across a great span of time. Dickens, writing week to week, never harbored such grandiose ambition. The closest any other author gets, at this level, to creating and sustaining a fantasy/reality world is Mark Twain in the Tom Sawyer novels, of which four were successfully published during his lifetime.

Tom is supposed to be 11 or 12 years old when the cycle begins, a year or so older than Harry, and Twain employs him as a paradigm of lost American innocence, a nostalgic tweak at his mostly adult readership. Harry represents no other time or place. He is what he is: an English boy who is sent off to boarding school, where, from friends and teachers, he discovers both his own nature as a wizard and the hair-raising hazards that he may face at any time.

It is here that Ms. Rowling achieves the double-whammy of getting child readers to emote with a central character who is outwardly like them, inwardly not, empowered by wizardry yet otherwise ordinary. Tom's magic is pure mischief, fooling another kid to whitewash his aunt's fence. Harry's is existential. He pretends at normality, knowing he can shed it at will to frustrate the forces of evil.

Harry, nevertheless, arouses greater empathy because he seems to be a child liberated from the control of dull, distracted adults, rejecting his soulless environment. No sensitive child would want to grow up to be Harry's Muggle relatives, Mr. and Mrs. Dursley of No. 4 Privet Drive. Harry Potter allows children of the suburbs to loathe their Little Boxes, to fly a nebulous broom, play non-televisable sports and aspire to a life out of the ordinary. Whether read in Seattle, Sarajevo or Soweto, Harry gives children a license to judge the adult world—and find it wanting.

Few works of children's literature have grasped this rejectionist need so intuitively. "Little House on the Prairie," that inexhaustible American saga, fostered civic conformity. C.S. Lewis, in the "Chronicles of Narnia," bred good little Christians. Roald Dahl, ostensibly rebellious, invented a controllable naughtiness in his chocolate factory. The magnetic charm of Harry is that he has no limits: He can do anything, fly anywhere and yet remain sympathetic and real, an achievable role model. The only other modern work of children's literature that pulls off this otherworld/our-world duality is Mark Haddon's brilliant and disturbing "The Curious Incident of the Dog in the Night Time," in which a 15-year-old boy with Asperger's syndrome evokes an outsider-insider dichotomy. Mr. Haddon, like Ms. Rowling, understands that children need to express an innate difference.

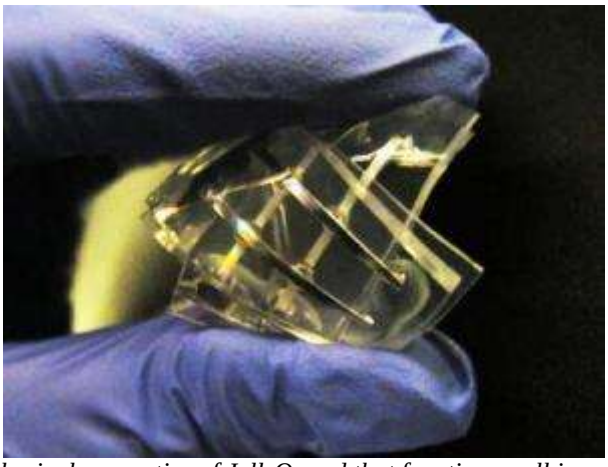
Much of Harry Potter's iconoclasm disappears on film, due to Hollywood's regimented conformities of set, sound and stereotyped character. It speaks volumes for Ms. Rowling's novels that many children will forever imagine Harry Potter as quite different from the actor who plays him, Daniel Radcliffe. By rekindling the urge to read, J.K. Rowling trumped the machine-tooled dream factories.

Ever since she finished "Harry Potter and the Deathly Hallows" in 2007, Ms. Rowling has given tantalising hints of future ventures. Now Pottermore, a website that goes live on July 31, has been announced as the sole source for electronic downloads of the Harry Potter books, as well as any prospective future texts. Still only 45, Rowling seems ready to step up her game. From Dickens, with his 20 novels, she must know that what a writer does is write. More books, and then more. Hers may not continue to appear as print on paper for much longer, but they will always exist to be read, one word to the next: the word triumphant.

—Mr. Lebrecht's "Why Mahler?" will appear in paperback in September.

http://online.wsj.com/article/SB10001424052702304584004576419742308635716.html?mod=WSJ_Books_LS_Books_6

Soft Memory Device Opens Door to New Biocompatible Electronics



Researchers have created a memory device with the physical properties of Jell-O, and that functions well in wet environments. (Credit: Michael Dickey, North Carolina State University)

ScienceDaily (July 14, 2011) — Researchers from North Carolina State University have developed a memory device that is soft and functions well in wet environments -- opening the door to a new generation of biocompatible electronic devices.

"We've created a memory device with the physical properties of Jell-O," says Dr. Michael Dickey, an assistant professor of chemical and biomolecular engineering at NC State and co-author of a paper describing the research.

Conventional electronics are typically made of rigid, brittle materials and don't function well in a wet environment. "Our memory device is soft and pliable, and functions extremely well in wet environments -- similar to the human brain," Dickey says.

Prototypes of the device have not yet been optimized to hold significant amounts of memory, but work well in environments that would be hostile to traditional electronics. The devices are made using a liquid alloy of gallium and indium metals set into water-based gels, similar to gels used in biological research.

The device's ability to function in wet environments, and the biocompatibility of the gels, mean that this technology holds promise for interfacing electronics with biological systems -- such as cells, enzymes or tissue. "These properties may be used for biological sensors or for medical monitoring," Dickey says.

The device functions much like so-called "memristors," which are vaunted as a possible next-generation memory technology. The individual components of the "mushy" memory device have two states: one that conducts electricity and one that does not. These two states can be used to represent the 1s and 0s used in binary language. Most conventional electronics use electrons to create these 1s and 0s in computer chips. The mushy memory device uses charged molecules called ions to do the same thing.

In each of the memory device's circuits, the metal alloy is the circuit's electrode and sits on either side of a conductive piece of gel. When the alloy electrode is exposed to a positive charge it creates an oxidized skin that makes it resistive to electricity. We'll call that the 0. When the electrode is exposed to a negative charge, the oxidized skin disappears, and it becomes conducive to electricity. We'll call that the 1.

Normally, whenever a negative charge is applied to one side of the electrode, the positive charge would move to the other side and create another oxidized skin -- meaning the electrode would always be resistive. To solve that problem, the researchers "doped" one side of the gel slab with a polymer that prevents the formation of a stable oxidized skin. That way one electrode is always conducive -- giving the device the 1s and 0s it needs for electronic memory.

The paper was published online July 4 by *Advanced Materials*. The paper was co-authored by NC State Ph.D. students Hyung-Jun Koo and Ju-Hee So, and NC State INVISTA Professor of Chemical and Biomolecular Engineering Orlin Velev. The research was supported by the National Science Foundation and the U.S. Department of Energy.

NC State's Department of Chemical and Biomolecular Engineering is part of the university's College of Engineering.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **North Carolina State University**.

Journal Reference:

1. Hyung-Jun Koo, Ju-Hee So, Michael D. Dickey, Orlin D. Velev. **Towards All-Soft Matter Circuits: Prototypes of Quasi-Liquid Devices with Memristor Characteristics**. *Advanced Materials*, 2011; DOI: 10.1002/adma.201101257

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Young Men and Fire

By ADAM SAVAGE

Harrison Shull/Getty Images

I have proof that we are not so far advanced as we would like to imagine, we humans. We may drive to work in hybrid, air-conditioned cars, eat hydroponically grown tomatoes on our salad and have the ability to instantly listen to any song in the history of music, but we are not as far from the roving bands on the veldt as we hope. My evidence: fire.

You need only see humans' reactions to fire, in every form, to comprehend its import to us on a cellular level. Somewhere deep in our amygdalas we know how powerful our mastery over this primal force is, and how much that mastery separates us from all other living things.

Children are especially connected to this fascination. I see my boys (12-year-old twins) playing with dinner candles just as I did at their age, with the same rapt fascination. I tell them to stop, just like my parents did—it's in the rulebook.

My own experiments with fire began with yogurt cups—Dannon, to be specific. If you're my age, you remember that Dannon yogurt used to come in paper containers that had a wax coating. I spent hours lighting those on fire on my parents' hearth and watching them slowly burn. I got in trouble when I left an indelible ring on the stone (whoops!)—and, ever after, made sure to burn the cups in the exact same spot.

My fire-exploration phase abruptly ended when (I've never told this story) I almost incinerated the patch of land around our summer house. I had wanted only to light a firecracker behind the tennis court. But I'd thoughtlessly dropped the wooden match I'd used to light it into dried leaves nearby (the only firecrackers I

could get hold of were cheap and went off very quickly). I put out the fire with my cousin Lucy's tennis racket, but the strings were nylon instead of catgut, and I returned it to her a fried, burnt mess. Sorry, Lucy!

If only I had had a reference like William Gurstelle's terrific "The Practical Pyromaniac." Mr. Gurstelle has also written "Backyard Ballistics," "The Art of the Catapult" and "Absinthe & Flamethrowers," among other useful works. I'm glad a litigious personal-injury lawyer hasn't stunted the author's Promethean desires to bring important information to the uninitiated.

But he's not just a bringer of fire—he's a master of his topic, too. "The Practical Pyromaniac" provides no-nonsense walkthroughs of a host of excellent, intriguing and magical experiments (with plenty of very sage safety talk and advice). Detailed and thoughtful instructions lead aspiring firebugs from creating an olive-oil lamp and one-candlepower engine to making an operating fire piston and a blindingly bright arc light. Some of the experiments contained in this book are simple; some are reasonably complex. Many are potentially dangerous, but Mr. Gurstelle carefully explains why they're dangerous. Knowing exactly why stuff is dangerous is 90% of safety.

"The Practical Pyromaniac" is also not merely what it promises: In fact it's an excellent history of those who played with fire until they learned something from it. We're introduced to Michael Faraday (1791-1867), a man who besides being a brilliant self-taught scientist was able to hold Victorian audiences rapt through a six-part lecture series called "The Chemical History of the Candle." We meet Count Rumford (1753-1814), who in 1798 formally established how friction converts kinetic energy into heat, a process this book illustrates with that old favorite, the fire drill. (Rumford also founded the Royal Institution, where Faraday would give his lectures.)

The shy Henry Cavendish (1731-1810), barely able to speak in public (forget about it if women were present), proved that air and water were not elements in and of themselves but were made up of even more basic stuff. He paved the road to our current understanding of the elements, and Mr. Gurstelle drives home that lesson by showing how to generate (flammable) hydrogen gas by exposing pennies to hydrochloric acid.

The Practical Pyromaniac

By William Gurstelle
Chicago Review, 212 pages, $16.95

The stories told about these men intertwine and demonstrate in a lovely way the twisted path of scientific discovery. Mr. Gurstelle talks about how parts of Joseph Priestley's important work in isolating oxygen led to Antoine Lavoisier's understanding of what is actually happening in a candle flame. "Scientists finally knew what fire is," the author writes, "a chemical reaction that always involves the combination of the burning material with oxygen." Mr. Gurstelle describes breakthrough experiments these men did, which helped to open up our understanding of the inner mechanics of the universe, and then he shows us how to perform these experiments in our kitchens, with some stuff from the hardware store.

This, perhaps, is the part of the book that is closest to my heart, the lesson that most people need to know about science: how accessible it is. These men had access to a fraction of the tools that I have in my shop, yet they cracked open nature and took a look inside simply by asking smart questions and figuring out ways to answer them.

It's a lovely book. My only (small) beef is that I'd have liked more complete illustrations and diagrams.

I took my boys camping last summer. We drove a hair-raising set of muddy cliffside roads to a secluded campground in the middle of nowhere. We lit a fire and ate mediocre food and slept in a soggy tent and woke

up in a puddle. What do they remember from that trip? The fire. Only the fire. All the sticks they burned in it. Watching it change as the evening wore on. Getting close and burning new things. Their fascination with our firepit is the foundation of all scientific discovery. This is, I believe, Mr. Gurstelle's point, and he has explored it admirably.

Mr. Savage is the co-executive producer and co-host of "Mythbusters."

http://online.wsj.com/article/SB10001424052702303365804576432001318892600.html?mod=WSJ_Books_LS_Books_6

First Adenovirus to Jump Between Monkeys and Humans Confirmed

Adult Male Titi Monkey and his Infant at the California National Primate Research Center in Davis, California. A novel adenovirus species, named TMAdV (titi monkey adenovirus), was found to be the cause of a deadly pneumonia outbreak that killed more than one-third of the titi monkey colony and also infected a human scientist at the center. (Credit: Photograph courtesy of Kathy West)

ScienceDaily (July 15, 2011) — A novel virus that spread through a California monkey colony in late 2009 also infected a human researcher and a family member, UCSF researchers have found, the first known example of an adenovirus "jumping" from one species to another and remaining contagious after the jump.

In a study by the UCSF Viral Diagnostics and Discovery Center, which identified the new virus at the time of the outbreak, researchers confirmed it was the same virus in the New World titi monkeys and the two humans. They also confirmed that the virus is highly unusual in both populations, suggesting that it may have originated from a third, unidentified species.

The direction in which the virus spread, however -- from monkeys to humans or vice versa -- remains a mystery.

Findings appear in the July 14 issue of *PLoS Pathogens*, a weekly journal of the Public Library of Science.

Adenoviruses naturally infect many animals, including humans, monkeys and rodents, and are known to cause a wide range of clinical illnesses in humans, from cold-like symptoms to diarrhea and pneumonia. Unlike influenza or coronaviruses, adenoviruses had not been known to spread from one species to another.

"Now adenoviruses can be added to the list of pathogens that have the ability to cross species," said Charles Chiu, MD, PhD, an assistant professor of laboratory medicine and infectious diseases at UCSF and director of the viral diagnostics center. "It's been hinted at before, but this study is the first to document these viruses crossing the species barrier in real time."

The virus, which researchers have named titi monkey adenovirus (TMAdV), infected more than a third of the titi monkeys in the California National Primate Research Center (CNPRC) in late 2009. In the monkeys, the

virus was devastating, causing an upper respiratory illness that progressed to pneumonia and eventually killed 19 of the 23 monkeys (83 percent) that became sick, including healthy young adult monkeys.

Around the time of the outbreak, a researcher who was taking care of the sick monkeys also developed an upper respiratory infection, with fever, chills and a cough that lasted four weeks, as did two members of the researchers' family who had no contact with the monkey colony. All three recovered fully without medical treatment.

The primate center called Chiu when the illness spread through the colony to help identify the pathogen and prevent its spread to other animals. The UCSF Viral Diagnostics and Discovery Center specializes in using a microarray Virochip technology developed at UCSF to identify viruses affecting humans, animals, insects or plants.

Because the researcher's illness was not reported for several months, the virus could no longer be detected directly, so Chiu worked with the California Department of Public Health to conduct antibody testing on the monkeys, the researcher and two of the researcher's family members who also reported having been sick.

Antibodies are a product of the body's immune response to pathogens and generally remain in the bloodstream for several months after infection. As a result, they serve as a marker of whether a person was exposed to a specific virus. Both the monkeys and researcher tested positive for antibodies to the TMAdV virus, as did one of the two family members. No other humans at the center were found to have been infected.

The UCSF team found that the new virus clearly belonged to the adenovirus family, yet was unlike any adenovirus ever reported to infect humans or monkeys, including from large-scale studies by public health agencies such as the U.S. Centers for Disease Control and Prevention. The new virus was so unusual, in fact, that it shares only 56 percent of its DNA to its closest viral relative.

"This is clearly a new species of adenovirus and it's quite different from anything we've seen previously," said Chiu. "Given the unusually high fatality rate of TMAdV in the titi monkeys, they are not likely to be the native host species for this virus. We still don't know what species is the natural host."

Chiu said the lack of previous records of this virus in humans indicates that it is also unlikely to have started with the researcher. In testing other monkeys at the primate center, the team found one healthy rhesus (Old World) monkey with antibodies to TMAdV, which Chiu said could indicate that the virus originated in Old World monkeys, then spread to the New World colony that lacked antibodies against it.

The viral center is conducting further studies in both humans and monkeys in Brazil and Africa to determine whether the virus is common in wild populations of either Old World or New World monkeys, and whether it has crossed species in those settings to humans who live nearby.

Eunice C. Chen, of the UCSF Viral Diagnostics and Discovery Center, was first author on the paper. Co-authors include Shigeo Yagi and David P. Schnurr, of the Viral and Rickettsial Disease Laboratory in the California Department of Public Health, Richmond, Calif.; and Kristi R. Kelly, Sally P. Mendoza, Nicole Maninger, Ann Rosenthal, Abigail Spinner, Karen L. Bales and Nicholas W. Lerche, of the California National Primate Research Center, UC Davis, Davis, Calif. Bales is also with the UC Davis Department of Psychology.

This work was supported by grants from the NIH and an Abbott Viral Discovery Award to Charles Chiu. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. UCSF has filed a patent application related to the novel adenovirus TMAdV.

Story Source:

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Journal Reference:

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http://www.sciencedaily.com/releases/2011/07/110714191427.htm

New Planets Feature Young Star and Twin Neptunes

Illustration of a system with twin Neptune-like planets. (Credit: Copyright University of Oxford)

ScienceDaily (July 14, 2011) — An international team, including Oxford University scientists, has discovered 10 new planets. Amongst them is one orbiting a star perhaps only a few tens of million years old, twin Neptune-sized planets, and a rare Saturn-like world.

The planets were detected using the CoRoT (Convection, Rotation and Transits) space telescope, operated by the French space agency CNES. It discovers planets outside our solar system -- exoplanets -- when they 'transit', that is pass in front of their stars.

The new finds were announced on 14 June at the Second CoRoT Symposium, held in Marseille.

Out of the ten new exoplanets (CoRoT-16b through to 24b and c) seven are hot Jupiters some of which are unusually dense and/or on unusually elongated orbits, and one is in orbit around an unusually young star. The announcement also includes a planet slightly smaller than Saturn, and two Neptune-sized planets orbiting the same star.

Dr Suzanne Aigrain of Oxford University's Department of Physics, lead UK scientist for CoRoT, said: 'CoRoT-18b is special because its star might be quite young. Finding planets around young stars is particularly interesting because planets evolve very fast initially, before settling into a much steadier pattern of evolution.

'If we want to understand the conditions in which planets form, we need to catch them within the first few hundred million years. After that, the memory of the initial conditions is essentially lost. In the case of CoRoT-18, different ways of determining the age give different results, but it's possible that the star might be only a few tens of millions of years old. If this is confirmed, then we could learn a lot about the formation and

early evolution of hot gas giant planets by comparing the size of CoRoT-18b to the predictions of theoretical models.'

Another system of particular interest is CoRoT-24, which is around 4,400 light years from us and consists of a star just a little smaller than our Sun, orbited by two transiting planets.

'The first of these planets is three times larger than the Earth, and takes 5.1 days to orbit the star, whilst the second is 4.8 times larger than the Earth and takes 11.8 days to complete an orbit. So these planets are similar to Neptune in size, but much hotter,' said Dr Aigrain.

'However, we don't know yet whether they are also similar to Neptune in composition, because even with the best instruments in the world, we could only obtain upper limits on their masses. It's the first system with two transiting planets found by CoRoT, and it ties in well with similar transiting planet systems found by the Kepler mission.'

Elsewhere CoRoT-22b is a rare example of a planet similar in size to Saturn. Located around 2,000 light years from us it takes about 10 days to orbit its star, which is slightly hotter than our Sun. Dr Aigrain said: 'we have only an upper limit on its mass, but this is enough to determine that is density is not much more than that of Jupiter, which means it has a predominantly gaseous composition, although it could also contain significant quantities of rock and ice.'

Once CoRoT detects a transit, additional observations are made from the ground, using a number of telescopes all over the world. Although astronomers cannot see the planets directly, they use the space- and ground-based data to measure the sizes, masses, and orbits of these new planets precisely. This is why, among all known exoplanets, those with transits yield the most complete information about planet formation and evolution.

The new planets will also be presented at a seminar on June 15th at the Institute of Physics in London.

The 10 new planets are:

CoRoT-16b: A puffed-up short-period giant planet, with half the Jupiter mass and its full radius. It orbits in 5.3 days around a mature Sun-like star with an age of 6 billion years. The orbit of this planet is highly elongated which is rare for such an old, close-in planet.

CoRoT-17b: A massive giant planet around a star with an age of 10 billion years, or twice as old as our Sun. It orbits in 3.7 days, has 2.4 Jupiter masses and a density twice that of Jupiter. Observing such an old planetary system is important for understanding the long term evolution of giant planets**.**

CoRoT-18b: Unlike the previous CoRoT planets this "Hot Jupiter" orbits a young star that is a mere 600 million years old. This planet has a size 1.4 times that of Jupiter, but 3.5 times its mass. This planet is very dense, with almost twice the density of Jupiter.

CoRoT-19b: A planet with the same mass as Jupiter but 1.5 times the size. It has a density much less than that of Saturn, the least dense planet in our solar system.

CoRoT-20b: A "Hot Jupiter" in an eccentric orbit with a period of 9.2 days. CoRoT-20b is special because it has a very elongated orbit which may be related to its extremely high density. It has a density twice that of Mars, even though it is a gaseous giant planet. **CoRoT-21b**: A giant gas planet with a size 1.3 times that of Jupiter and 2.5 times the mass. This is one of the faintest CoRoT stars for which the planet mass has been

determined. These mass measurements required observations with the Keck 10m telescope in Hawaii, USA, the largest telescope in the world.

CoRoT-22b*: This planet has a size of 0.74 radii that of Saturn. The mass of this exoplanet has yet to be determined precisely, but it is certainly less than half that of Saturn.

CoRoT-23b: A "Hot Jupiter" in a 3.6 day orbit.

CoRoT-24b and **24c***: A system with two transiting planets of Neptune size in orbits of 5.1 and 11.8 days. The planets have sizes of 1 and 1.4 times that of Neptune, respectively.

*Despite their best efforts, the team were not able to detect the radial velocity signatures of CoRoT-22b, 24b and 24c unambiguously. However, they were able to rule out almost every configuration of stars that could mimic a planet in the CoRoT data at high confidence.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **University of Oxford**.

http://www.sciencedaily.com/releases/2011/07/110714102456.htm

New Way to Store Sun's Heat: Modified Carbon Nanotubes Can Store Solar Energy Indefinitely, Then Be Recharged by Exposure to the Sun

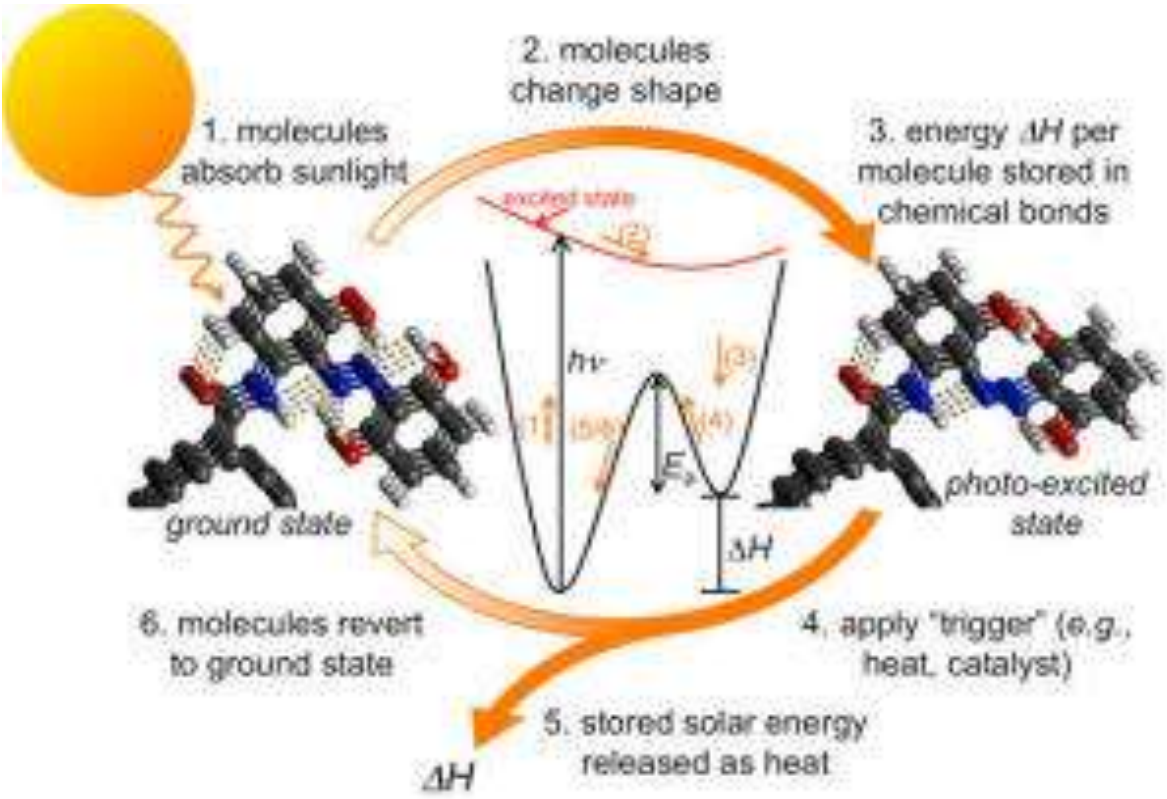


Illustration. (Credit: Image courtesy of Grossman/Kolpak)

ScienceDaily (July 14, 2011) — A novel application of carbon nanotubes, developed by MIT researchers, shows promise as an innovative approach to storing solar energy for use whenever it's needed.

Storing the sun's heat in chemical form -- rather than converting it to electricity or storing the heat itself in a heavily insulated container -- has significant advantages, since in principle the chemical material can be stored for long periods of time without losing any of its stored energy. The problem with that approach has been that until now the chemicals needed to perform this conversion and storage either degraded within a few cycles, or included the element ruthenium, which is rare and expensive.

Last year, MIT associate professor Jeffrey Grossman and four co-authors figured out exactly how fulvalene diruthenium -- known to scientists as the best chemical for reversibly storing solar energy, since it did not degrade -- was able to accomplish this feat. Grossman said at the time that better understanding this process could make it easier to search for other compounds, made of abundant and inexpensive materials, which could be used in the same way.

Now, he and postdoc Alexie Kolpak have succeeded in doing just that. A paper describing their new findings has just been published online in the journal *Nano Letters*, and will appear in print in a forthcoming issue.

The new material found by Grossman and Kolpak is made using carbon nanotubes, tiny tubular structures of pure carbon, in combination with a compound called azobenzene. The resulting molecules, produced using nanoscale templates to shape and constrain their physical structure, gain "new properties that aren't available"

in the separate materials, says Grossman, the Carl Richard Soderberg Associate Professor of Power Engineering.

Not only is this new chemical system less expensive than the earlier ruthenium-containing compound, but it also is vastly more efficient at storing energy in a given amount of space -- about 10,000 times higher in volumetric energy density, Kolpak says -- making its energy density comparable to lithium-ion batteries. By using nanofabrication methods, "you can control [the molecules'] interactions, increasing the amount of energy they can store and the length of time for which they can store it -- and most importantly, you can control both independently," she says.

Thermo-chemical storage of solar energy uses a molecule whose structure changes when exposed to sunlight, and can remain stable in that form indefinitely. Then, when nudged by a stimulus -- a catalyst, a small temperature change, a flash of light -- it can quickly snap back to its other form, releasing its stored energy in a burst of heat. Grossman describes it as creating a rechargeable heat battery with a long shelf life, like a conventional battery.

One of the great advantages of the new approach to harnessing solar energy, Grossman says, is that it simplifies the process by combining energy harvesting and storage into a single step. "You've got a material that both converts and stores energy," he says. "It's robust, it doesn't degrade, and it's cheap." One limitation, however, is that while this process is useful for heating applications, to produce electricity would require another conversion step, using thermoelectric devices or producing steam to run a generator.

While the new work shows the energy-storage capability of a specific type of molecule -- azobenzene-functionalized carbon nanotubes -- Grossman says the way the material was designed involves "a general concept that can be applied to many new materials." Many of these have already been synthesized by other researchers for different applications, and would simply need to have their properties fine-tuned for solar thermal storage.

The key to controlling solar thermal storage is an energy barrier separating the two stable states the molecule can adopt; the detailed understanding of that barrier was central to Grossman's earlier research on fulvalene diruthenium, accounting for its long-term stability. Too low a barrier, and the molecule would return too easily to its "uncharged" state, failing to store energy for long periods; if the barrier were too high, it would not be able to easily release its energy when needed. "The barrier has to be optimized," Grossman says.

Already, the team is "very actively looking at a range of new materials," he says. While they have already identified the one very promising material described in this paper, he says, "I see this as the tip of the iceberg. We're pretty jazzed up about it."

Yosuke Kanai, assistant professor of chemistry at the University of North Carolina at Chapel Hill, says "the idea of reversibly storing solar energy in chemical bonds is gaining a lot of attention these days. The novelty of this work is how these authors have shown that the energy density can be significantly increased by using carbon nanotubes as nanoscale templates. This innovative idea also opens up an interesting avenue for tailoring already-known photoactive molecules for solar thermal fuels and storage in general."

Story Source:

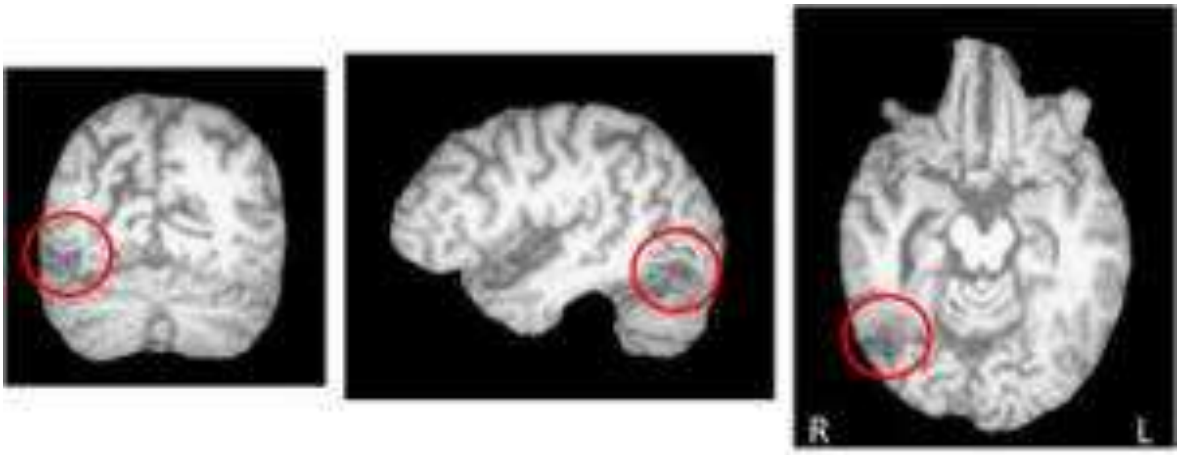
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Massachusetts Institute of Technology**. The original article was written by David L. Chandler, MIT News Office.

Journal Reference:

1. Alexie M. Kolpak, Jeffrey C. Grossman. **Azobenzene-Functionalized Carbon Nanotubes As High-Energy Density Solar Thermal Fuels**. *Nano Letters*, 2011; : 110705085331088 DOI: 10.1021/nl201357n

http://www.sciencedaily.com/releases/2011/07/110713121301.htm

Neuroscientists Uncover Neural Mechanisms of Object Recognition



Neuroscientists have examined the brain of a person with object agnosia, a deficit in the ability to recognize objects that does not include damage to the eyes or a general loss in intelligence, and have uncovered the neural mechanisms of object recognition. (Credit: Image courtesy of Carnegie Mellon University)

ScienceDaily (July 14, 2011) — Certain brain injuries can cause people to lose the ability to visually recognize objects -- for example, confusing a harmonica for a cash register.

Neuroscientists from Carnegie Mellon University and Princeton University examined the brain of a person with object agnosia, a deficit in the ability to recognize objects that does not include damage to the eyes or a general loss in intelligence, and have uncovered the neural mechanisms of object recognition. The results in the July 15th issue of the journal *Neuron*, describe the functional neuroanatomy of object agnosia and suggest that damage to the part of the brain critical for object recognition can have a widespread impact on remote parts of the cortex.

"One of the persisting controversies in the field of visual neuroscience concerns the regions of cortex that subserve the human ability to recognize objects as efficiently and accurately as we do, and it's been an elusive topic until now," said Marlene Behrmann, professor of psychology at CMU and an expert in using brain imaging to study the visual perception system.

To gain new insight into the neural basis of object recognition, the research team used neuroimaging and behavioral investigations to study visual and object-selective responses in the cortex of healthy controls and a participant called SM who, following selective brain damage to the right hemisphere of the brain, exhibited object agnosia.

The researchers discovered that the functional organization of the "lower" visual cortex, where the image from the retina is initially processed, was similar in SM and control subjects. However, SM exhibited decreased object-selective responses in the brain tissue in and around the brain lesion, and in more distant cortical areas that are also known to be involved in object recognition. Unexpectedly, the decrease in object-selective responses was also observed in corresponding locations of SM's structurally intact left hemisphere.

"What was perhaps the most dramatic, controversial and counter-intuitive result was that while the lesion was in the right hemisphere, and quite small, we found that the same region in the left hemisphere was also not operating normally," Behrmann said.

She added, "These results will force us in the field to step back a little and rethink the way we understand the relationship between brain and behavior. We now need to take into account that there are multiple parts of the brain that underlie object recognition, and damage to any one of those parts can essentially impair or decrease the ability to normally recognize objects."

Additionally, the researchers found that an area of the brain called the right lateral fusiform gyrus is vital for object recognition. There also appeared to be some functional reorganization in intact regions of SM's damaged right hemisphere, suggesting that neural plasticity is possible even when the brain is damaged in adulthood.

"To our knowledge, this study constitutes the most extensive functional analysis of the neural substrate underlying object agnosia and offers powerful evidence concerning the neural representations mediating object perception in normal vision," said Christina Konen, a postdoctoral fellow at Princeton and lead author of the study.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Carnegie Mellon University**.

Journal Reference:

1. Christina S. Konen, Marlene Behrmann, Mayu Nishimura, Sabine Kastner. **The Functional Neuroanatomy of Object Agnosia: A Case Study**. *Neuron*, 14 July 2011; 71(1) pp. 49 - 60 DOI: 10.1016/j.neuron.2011.05.030

http://www.sciencedaily.com/releases/2011/07/110713131429.htm

Soil Microbes Accelerate Global Warming

More carbon dioxide in the atmosphere causes soil to release the potent greenhouse gases methane and nitrous oxide. (Credit: © strixcode / Fotolia)

ScienceDaily (July 14, 2011) — More carbon dioxide in the atmosphere causes soil to release the potent greenhouse gases methane and nitrous oxide, new research published in this week's edition of *Nature* reveals. "This feedback to our changing atmosphere means that nature is not as efficient in slowing global warming as we previously thought," said Dr Kees Jan van Groenigen, Research Fellow at the Botany department at the School of Natural Sciences, Trinity College Dublin, and lead author of the study.

Van Groenigen, along with colleagues from Northern Arizona University and the University of Florida, gathered all published research to date from 49 different experiments mostly from North America, Europe and Asia, and conducted in forests, grasslands, wetlands, and agricultural fields, including rice paddies. The common theme in the experiments was that they all measured how extra carbon dioxide in the atmosphere affects how soils take up or release the gases methane and nitrous oxide.

The research team used a statistical technique called meta-analysis, or quantitative data synthesis, a powerful tool for finding general patterns in a sea of conflicting results. "Until now, there was no consensus on this topic, because results varied from one study to the next," explained Professor Craig Osenberg of the University of Florida and co-author of the study. "However, two strong patterns emerged when we analysed all the data: firstly more CO_2 boosted soil emissions of nitrous oxide in all the ecosystems, and secondly, in rice paddies and wetlands, extra CO_2 caused soils to release more methane." Wetlands and rice fields are two major sources of methane emissions to the atmosphere.

The culprits are specialised microscopic organisms in soil, that respire the chemicals nitrate and carbon dioxide, like humans respire oxygen. The microbes also produce methane, a greenhouse gas 25 times more

powerful than carbon dioxide, and nitrous oxide, 300 times more potent than carbon dioxide. Their oxygen-free habit is one of the reasons these microorganisms flourish when atmospheric carbon dioxide concentrations increase. Van Groenigen explained: "The higher CO_2 concentrations reduce plant water use, making soils wetter, in turn reducing the availability of oxygen in soil, favoring these microorganisms."

The other reason these microorganisms become more active is that increasing CO_2 makes plants grow faster, and the extra plant growth supplies soil microorganisms with extra energy, pumping up their metabolism. This extra plant growth is one of the main ways ecosystems could slow climate change. With more CO_2, plants grow more, soaking up carbon dioxide through photosynthesis, and, the hope is that they also lock away carbon in wood and soil. But this new work shows that at least some of that extra carbon also provides fuel to microorganisms whose byproducts, nitrous oxide and methane, end up in the atmosphere and counteract the cooling effects of more plant growth.

"It's an ecological point and counterpoint: the more the plants soak up CO_2, the more microbes release these more potent greenhouse gases," said Bruce Hungate, Professor at Northern Arizona University and co-author on the study. "The microbial counterpoint is only partial," continued Hungate, "reducing the cooling effect of plants by about 20%."

But it's an ecological surprise, too, and one that climate models will need to reckon with as they further refine pictures of the climate of the future. "By overlooking the key role of these two greenhouse gases, previous studies may have overestimated the potential of ecosystems to mitigate the greenhouse effect," van Groenigen concluded.

Story Source:

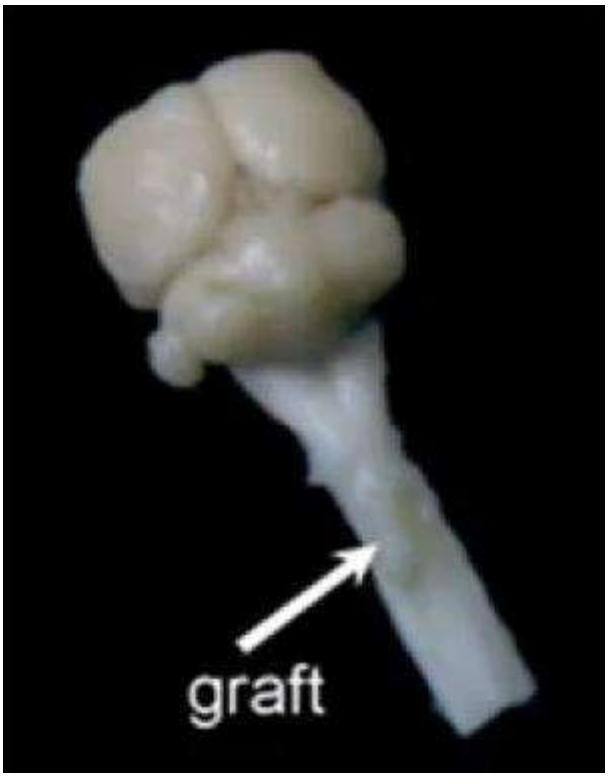
The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Trinity College Dublin**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Alexander Knohl, Edzo Veldkamp. **Global change: Indirect feedbacks to rising CO2**. *Nature*, 2011; 475 (7355): 177 DOI: 10.1038/475177a

http://www.sciencedaily.com/releases/2011/07/110713131423.htm

Breathing Restored After Spinal Cord Injury in Rodent Model



The graft. (Credit: Image courtesy of Case Western Reserve University)

ScienceDaily (July 14, 2011) — Researchers at Case Western Reserve University School of Medicine bridged a spinal cord injury and biologically regenerated lost nerve connections to the diaphragm, restoring breathing in an adult rodent model of spinal cord injury. The work, which restored 80 to more than 100 percent of breathing function, will be published in the online issue of the journal *Nature* July 14. The scientists say that more testing is necessary, but are hopeful their technique will quickly be used in clinical trials.

Restoration of breathing is the top desire of people with upper spinal cord injuries. Respiratory infections, which attack through the ventilators they rely on, are their top killer.

"We've shown for the very first time that robust, long distance regeneration can restore function of the respiratory system fully," said Jerry Silver, professor of neurosciences at Case Western Reserve and senior author.

Silver has been working 30 years on technologies to restore function to the nearly 1.2 million sufferers of spinal cord injuries. This restoration was accomplished using an old technology -- a peripheral nerve graft, and a new technology -- an enzyme, he explained.

Using a graft from the sciatic nerve, surgeons have been able to restore function to damaged peripheral nerves in the arms or legs for 100 years. But, they've had little or no success in using a graft on the spinal cord. Nearly 20 years ago, Silver found that after a spinal injury, a structural component of cartilage, called chondroitin sulfate proteoglycans, was present and involved in the scarring that prevents axons from regenerating and reconnecting. Silver knew that the bacteria Proteus vulgaris produced an enzyme called

Chondroitinase ABC, which could break down such structures. In previous testing, he found that the enzyme clips the inhibitory sugary branches of proteoglycans, essentially opening routes for nerves to grow through.

In this study, the researchers used a section of peripheral nerve to bridge a spinal cord injury at the second cervical level, which had paralyzed one-half of the diaphragm. They then injected Chondroitinase ABC. The enzyme opens passageways through scar tissue formed at the insertion site and promotes neuron growth and plasticity. Within the graft, Schwann cells, which provide structural support and protection to peripheral nerves, guide and support the long-distance regeneration of the severed spinal nerves. Nearly 3,000 severed nerves entered the bridge and 400 to 500 nerves grew out the other side, near disconnected motor neurons that control the diaphragm. There, Chondroitinase ABC prevented scarring from blocking continued growth and reinnervation.

"All the nerves hook up with interneurons and somehow unwanted activities are filtered out but signals for breathing come through," Silver said. "The spinal cord is smart."

Three months after the procedure, tests recording nerve and muscle activity showed that 80 to more than 100 percent of breathing function was restored. Breathing function was maintained at the same levels six months after treatment. A video about the research can be found at: http://www.youtube.com/watch?v=1YKVOAkdInM.

Silver's lab has already begun preliminary work to restore bladder function -- the top request of people who suffer lower spinal cord injuries. He is unsure whether the technique would be useful in restoring something as complicated as walking, but for breathing or holding and expelling urine, he said the tests so far indicate the procedure works well.

How long after injury the nerves are still capable of regeneration and re-connection, he doesn't know. But, Silver believes that more than the newly-injured could potentially benefit from the procedure.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Case Western Reserve University**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Warren J. Alilain, Kevin P. Horn, Hongmei Hu, Thomas E. Dick, Jerry Silver. **Functional regeneration of respiratory pathways after spinal cord injury**. *Nature*, 2011; 475 (7355): 196 DOI: 10.1038/nature10199

http://www.sciencedaily.com/releases/2011/07/110713131411.htm

Snow Leopard Population Discovered in Afghanistan

This is a snow leopard captured by remote camera in Afghanistan. A team of researchers from the Wildlife Conservation Society have discovered a surprisingly healthy population of these elusive big cats. (Credit: Wildlife Conservation Society)

ScienceDaily (July 13, 2011) — The Wildlife Conservation Society has discovered a surprisingly healthy population of rare snow leopards living in the mountainous reaches of northeastern Afghanistan's Wakhan Corridor, according to a new study.

The discovery gives hope to the world's most elusive big cat, which calls home to some of the world's tallest mountains. Between 4,500 and 7,500 snow leopards remain in the wild scattered across a dozen countries in Central Asia.

The study, which appears in the June 29th issue of the *International Journal of Environmental Studies*, is by WCS conservationists Anthony Simms, Zalmai Moheb, Salahudin, Hussain Ali, Inayat Ali and Timothy Wood.

WCS-trained community rangers used camera traps to document the presence of snow leopards at 16 different locations across a wide landscape. The images represent the first camera trap records of snow leopards in Afghanistan. WCS has been conserving wildlife and improving local livelihoods in the region since 2006 with support from the U.S. Agency for International Development (USAID).

"This is a wonderful discovery -- it shows that there is real hope for snow leopards in Afghanistan," said Peter Zahler, WCS Deputy Director for Asia Programs. "Now our goal is to ensure that these magnificent animals have a secure future as a key part of Afghanistan's natural heritage."

According to the study, snow leopards remain threatened in the region. Poaching for their pelts, persecution by shepherds, and the capture of live animals for the illegal pet trade have all been documented in the Wakhan Corridor. In response, WCS has developed a set of conservation initiatives to protect snow leopards. These include partnering with local communities, training of rangers, and education and outreach efforts.

Anthony Simms, lead author and the project's Technical Advisor, said, "By developing a community-led management approach, we believe snow leopards will be conserved in Afghanistan over the long term."

WCS-led initiatives are already paying off. Conservation education is now occurring in every school in the Wakhan region. Fifty-nine rangers have been trained to date. They monitor not only snow leopards but other species including Marco Polo sheep and ibex while also enforcing laws against poaching. WCS has also initiated the construction of predator-proof livestock corrals and a livestock insurance program that compensates shepherds, though initial WCS research shows that surprisingly few livestock fall to predators in the region.

In Afghanistan, USAID has provided support to WCS to work in more than 55 communities across the country and is training local people to monitor and sustainably manage their wildlife and other resources. One of the many outputs of this project was the creation of Afghanistan's first national park -- Band-e-Amir -- which is now co-managed by the government and a committee consisting of all 14 communities living around the park.

Snow leopards have declined by as much as 20 percent over the past 16 years and are considered endangered by the International Union for Conservation of Nature (IUCN).

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Wildlife Conservation Society**, via EurekAlert!, a service of AAAS.

Journal Reference:

1. Anthony Simms, Zalmai Moheb, Salahudin, Hussain Ali, Inayat Ali, Timothy Wood. **Saving threatened species in Afghanistan: snow leopards in the Wakhan Corridor**. *International Journal of Environmental Studies*, 2011; 68 (3): 299 DOI: 10.1080/00207233.2011.577147

http://www.sciencedaily.com/releases/2011/07/110713121430.htm

Reconnecting Children and Nature

It may not be recognized by the AMA, but nature deficit disorder is raising Cain with children in the industrialized world — and it can be fought.

By Judith Stock

What happens when children fail to bond with nature? Researchers believe the disconnect contributes to ADD, childhood obesity and a weakening of the necessity they will feel for environmental stewardship when the grow up. (Darrin Klimek/Getty Images)

Traditionally, nature has served as humanity's greatest teacher, the place where artists, poets and scientists go for inspiration. The natural world has the ability to draw us in and allow us to experience a sense of wonder.

But what happens when children fail to bond with nature?

Nature deficit disorder isn't a medical term but a social phenomenon identified by Richard Louv, the author of *Last Child in the Woods: Saving our Children from Nature Deficit Disorder*.

Nature deficit disorder describes the high cost of separation between nature and children — including attention deficit hyperactivity disorder, childhood obesity, higher rates of physical and emotional illness and vitamin D deficiency, to list a few.

"There is very little that children do in their lives that compares with their first experience in nature," Louv says.

Think back to your own childhood experience of being outside on a quest to discover your surroundings.

Today, instead of hiking, swimming and telling stories around campfires, children are more likely to attend computer or weight-loss camp, or play video games indoors. These activities relegate nature to a non-reality for children.

Louv cites an eye-opening 1991 study of three generations of 9-year-olds. It "found between 1970 and 1990, the radius around the home where children were allowed to roam on their own had shrunk to a ninth of what it had been in 1970."

As Louv explains, as a child, he'd spent time in nature and felt that he'd gained something important. Then, in the late 1980s, while interviewing people for a book he was writing about the changing realities of family life, he recognized there was a profound change in the ways that people viewed nature, yet no one had a way to describe that condition.

Connecting the Dots

Here are some activities that encourage that connection with nature:

If you can't come to one of the National Parks, join the WebRangers program, where kids can play interactive games, build a ranger station and other activities.

Enroll the family in nature clubs around the country that provide opportunities for families to get outside in the natural world.

Children and Nature Network resources and activities at
www.childrenandnature.org/research.

The National Wildlife Federation produces the GreenHour.org, an online resource providing parents with inspiration and the tools to make the outdoors a part of daily life.

Take a road trip to the Rachel Carson Homestead to foster a sense of wonder.

Step out your front door and track global climate change or the pigeons in your own neighborhood. Share your findings with real scientists. In so doing become part of a citizen science effort. Learn to do that and more in Eco-Tracking: On the trail of Habitat Change. This book by Daniel Shaw, in the UNM Press Barbara Guth Worlds of Wonder Science Series for Young Readers, tells the stories of how real young people are connecting with and caring for both their local environments and the world at large.

Over the next 12 to 15 years, researchers identified a growing gap between children and nature.

"Science now shows huge benefits to kids' health when spending time outdoors," Louv says. "The University of Illinois found that kids with ADD symptoms get better with just a little contact with nature. Research on childhood obesity suggests the more trees, grass and gardens in a neighborhood, the less obesity."

As John McKinney suggested in a 2009 Miller-McCune article, the sworn enemy of nature deficit disorder might be "active living research" — which, while it specifically focuses on inactivity, inevitably means pushing people outdoors.

In Louv's latest book, *The Nature Principle: Human Restoration and the End Of Nature-Deficit Disorder*, the author makes a convincing case that through a nature-balanced existence, the human race can thrive.

"We humans are essentially hunter-gatherer genotypes. Cognitive development is supposed to happen the way it does in hunting and gathering societies," says David Sobel, a senior faculty member at Antioch University New England and author of *Wild Play: Parenting Adventures in the Great Outdoors*.

"What we want for our children is a sense of interdependency with the natural world, so their roots are organic instead of mechanistic, like computers and technology," Sobel says. "Children are supposed to be outside as their language develops better. Kids develop a greater array of movement patterns while engaged in outdoor activities."

Parents are so overwhelmingly educated about the dangers kids might face being out of eyesight, with the end result being that today's children do without exploration time and free play. They are unwittingly assisted in the negative spiral by a built environment that doesn't stress the human-nature connection, although so-called "biophilic design" can go a long way toward addressing that.

"Parents have to manage their own fears about what could happen to their kids outside," Sobel says. "Don't merely look at the risks of outdoor play, but look at the benefits, as they far outweigh the risks."

It's become a curiosity for kids to stay out all day or for parents to allow this behavior; the reasons are parental fears and lack of parental or family supervision. But beyond the front lawn, there are others who are willing to teach nature.

Take Dan Shaw, for example. He's a middle-school science teacher at the private college-preparatory Bosque School and co-director of the Bosque Ecosystem Monitoring Program, in Albuquerque, N.M. The school began a program some 15 years ago to encourage kids to bond with nature by becoming young citizen scientists.

The Bosque School established a partnership with the University of New Mexico's biology department to monitor the wetland habitat along the Rio Grande River in the student's own neighborhoods. (Their technical reports are available on the school's website.)

The data and quality control follow protocols established by the university's biology department and used by government officials, both local and tribal, in New Mexico. "Our collected data is used to inform multimillion-dollar management decisions by corporations and the U.S. Army Corp of Engineers," Shaw notes proudly. Consequently, 5,000 students and teachers became citizen scientists, monitoring their home watershed in this nationally honored, student-centered program.

Such education doesn't have to be the province of the well off or the well placed, as shown in a nonprofit that operates at many Texas public schools in poorer and urban neighborhoods. The 8-year-old REAL School Garden program, which places a student-run garden on school grounds as a learning experience, has been useful for getting children outdoors and into nature, both physically and mentally.

Executive director Jeanne McCarty told Miller-McCune that the gardens create a virtuous circle when tied into school curricula: "Children are more engaged, more excited about learning, and I'd say the learning stays with them. Meanwhile, children learn about food, are inspired and [are] hopeful for the future."

The program has also taught adults how far children are from their roots. “We have children who didn’t recognize a blackberry,” McCarty said, “and I think about my own childhood and how common blackberries were – we were always foraging. I’ve also heard funny stories about potatoes growing under the ground, which is something they didn’t know.”

The National Park Service offers the great outdoors, along with special programs for children. One such program is the Junior Ranger program at California’s Yosemite National Park.

Children and parents can go to the visitor center in the park and, for $3.50, buy a *Junior Ranger Handbook*, an activity guide for children ages 7 to 13. The handbook includes ways to enjoy, interpret and identify nature by giving kids tasks to accomplish. “Kids bring their handbook to a ranger, and after, they repeat an oath about valuing nature, they get a badge,” says Kari Cobb, park ranger at Yosemite.

“Being in nature provides a setting to encourage children’s minds to relax,” she says. “When I was a kid, I grew up hiking with my parents. Today, I am a park ranger.”

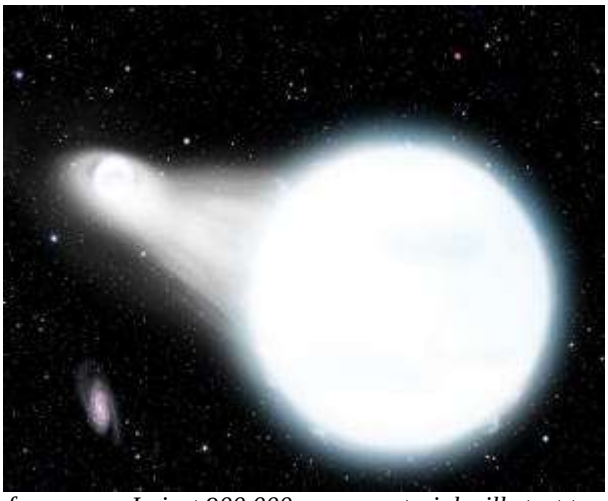
Cobb says you can start introducing kids to nature in small steps. “Anything that gets kids outside will enhance their appreciation of the natural world,” she explains. “My mom would say, ‘I’m going out to the garden. Why don’t you get your books and come outside with me and study on the porch?’”

Children are the stewards of the future. They need to connect with nature when they are young to develop a sense of accountability and stewardship for our planet.

It’s a simple solution. Get kids outside more often so they can discover the wonderment and adventure of the natural world.

http://www.miller-mccune.com/environment/reconnecting-children-and-nature-34252/

Evolved Stars Locked in Fatalistic Dance



Two white dwarfs have been discovered on the brink of a merger. In just 900,000 years, material will start to stream from one star to the other (as shown in this artist's conception), beginning the process that may end with a spectacular supernova explosion. Watching these stars fall in will allow astronomers to test Einstein's general theory of relativity as well as the origin of a special class of supernovae. (Credit: David A. Aguilar (CfA))

ScienceDaily (July 13, 2011) — White dwarfs are the burned-out cores of stars like our Sun. Astronomers have discovered a pair of white dwarfs spiraling into one another at breakneck speeds. Today, these white dwarfs are so near they make a complete orbit in just 13 minutes, but they are gradually slipping closer together. About 900,000 years from now -- a blink of an eye in astronomical time -- they will merge and possibly explode as a supernova. By watching the stars converge, scientists will test both Einstein's general theory of relativity and the origin of some peculiar supernovae.

The two white dwarfs are circling at a bracing speed of 370 miles per second (600 km/s), or 180 times faster than the fastest jet on Earth.

"I nearly fell out of my chair at the telescope when I saw one star change its speed by a staggering 750 miles per second in just a few minutes," said Smithsonian astronomer Warren Brown, lead author of the paper reporting the find.

The brighter white dwarf contains about a quarter of the Sun's mass compacted into a Neptune-sized ball, while its companion has more than half the mass of the Sun and is Earth-sized. A penny made of this white dwarf's material would weigh about 1,000 pounds on Earth.

Their mutual gravitational pull is so strong that it deforms the lower-mass star by three percent. If Earth bulged by the same amount, we would have tides 120 miles high.

The discovery team has been hunting for pairs of white dwarfs using the MMT telescope at the Whipple Observatory on Mt. Hopkins, Arizona. These star pairs are too close together to distinguish photographically. By looking at the spectra, however, Brown and his team were able to differentiate the two stars and measure their relative motions. These stars are also oriented such that they eclipse each other every 6 minutes.

"If there were aliens living on a planet around this star system, they would see one of their two suns disappear every 6 minutes -- a fantastic light show." said Smithsonian astronomer and co-author Mukremin Kilic.

These eclipses provide a very accurate clock, which is extremely useful for measuring any changes in the system.

General relativity predicts that moving objects will create ripples in the fabric of space-time, called gravitational waves. These waves carry away energy, causing the stars to inch closer together and orbit each other faster and faster.

"Though we have not yet directly measured gravitational waves with modern instruments, we can test their existence by measuring the change in the separation of these two stars," said co-author J. J. Hermes, a graduate student at the University of Texas at Austin. "Because they don't seem to be exchanging mass, this system is an exceptionally clean laboratory to perform such a test."

The team expects to conduct this test in a few months, when the star pair emerges from behind the Sun as seen from Earth.

Some models predict merging white dwarf pairs such as these are the source of a rare class of unusually faint stellar explosions called underluminous supernovae.

"If these systems are responsible for underluminous supernovae, we will detect these binary white dwarf systems with the same frequency that we see the supernovae. Our survey isn't complete, but so far, the numbers agree," said Brown.

This work will provide an important observational test on theories of white dwarf mergers, which are thought to produce many kinds of supernovae, not just the underluminous type.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Harvard-Smithsonian Center for Astrophysics**.

Journal Reference:

1. Warren R. Brown, Mukremin Kilic, J. J. Hermes, Carlos Allende Prieto, Scott J. Kenyon and D. E. Winget. **A 12 minute Orbital Period Detached White Dwarf Eclipsing Binary**. *The Astrophysical Journal Letters*, 2011 [link]

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